Camp Lick Project

Watershed Report

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for:
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February, 2, 2016

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Introduction

The purpose of this document is to assess the condition of hydrologic and riparian function and to analyze the effects of the proposed actions in the Camp Lick Project Environmental Assessment (EA). The EA builds on supporting reports and analysis to determine effects and restoration opportunities for roads, forest health, riparian corridors, stream channels, large wood, and water quality resources to build resilience within the Camp Lick planning area.

Regulatory Framework

The Malheur National Forest Land and Resource Management Plan (Malheur Forest Plan) provides standards and guidelines for watershed and hydrologic resources. Pertinent standards and guidelines from the Malheur Forest Plan, as amended by PACFISH/INFISH and Amendment #29 include:

- Malheur National Forest Land and Resource Management Plan (USDA Forest Service 1990).
  - PACFISH standard Timber Management (TM-1b)
  - PACFISH standard Fire/Fuels Management (FM-1)
  - PACFISH standard Roads Management (RF1-RF5)
  - PACFISH standard General Riparian Area Management (RA-2, 4, 5)
  - PACFISH standard Watershed and Habitat Restoration (WR-1, 3)
  - PACFISH standard Fisheries and Wildlife Restoration (FW-1)
  - Malheur Forest Plan Forest-wide standards 2, 4, 32, 47, 56, 57, 116-122, and 128
  - Malheur Forest Plan MA-3B standards 5, 8, 9, 11, 12, 21, 25, 30, 31, 32, 35, 36, 41, 42, 44, and 45
  - Amendment #29 standards 5a, 5b, 5c, and 5d
- Forest Service Manual Title 2500 – Watershed and Air Management
- General Water Quality Best Management Practices (USDA Forest Service 1988)
- National Best Management Practices for Water Quality Management on National Forest System Lands, Volume 1 (USDA Forest Service 2012)
- Clean Water Act
- National Environmental Policy Act of 1969
- Organic Administration Act of 1897
- Executive Orders 11988 and 11990

Resource Elements, Indicators and Measures

Hydrologic function and riparian fuction are the two resource elements used to describe the watershed condition for the Camp Lick planning area. Within the hydrolic function element, roads and forest health are two important indicators that strongly influence whether watershed conditions support high water quality and meet forest plan standards. For the riparian function element, riparian/wetland, stream channel and large woody debris conditions are the resource indicators pertinent for measuring watershed condition for the Camp Lick planning area.

Issue Statements

- Watershed conditions are not functioning properly and flow characteristics have been severely departed from desired conditions. Roads have drainage features that need maintenance. Water quality is at risk.
- Riparian ecosystems and their associated stream channels are not providing high quality functions, due to past practices interrupting biophysical processes. Riparian conditions are at risk due to uncharacteristic disturbance events in a changing climate. Past management practices in

riparian areas have left deficient conditions for beavers and large wood recruitment, and have connected and contagious, unhealthy stands at risk to wildfire.

Table 1. Resource elements, indicators and measures for assessing effects

Resource element	Resource indicator	Measure	Source
Hydrologic function	Roads and forest health	Hydrologically connected roads within proximity to streams and forest health	Malheur Forest Plan Forest-wide standards 2, 35, 41, and 47; PACFISH standards RF-2(d) and RF-3(c); and watershed condition framework.
Riparian function	Riparian/wetland, stream channel and large woody debris condition	Riparian/wetland, stream channel, and large woody debris	Oregon Department of Environmental Quality's (ODEQ) John Day River Basin Total Maximum Daily Load (TMDL) and Water Quality Management Plan (WQMP); Malheur Forest Plan Forest-wide standards 5, 8, and 9; and watershed condition framework.

Hydrologic Function

Affected Environment

Methodology

The methodology for assessing the hydrologic function condition was completed through evaluating site specific data collected from 2004 through the 2016 field season, as well as indicators in the watershed condition classification system and Forest Vegetative Simulator (FVS; generated by project silviculturist. Data collected in the field for hydrologic function included road condition surveys and stand exams. Stand exam plots were established in both riparian and upland stands. Previous roads analysis and watershed improvement tracking systems were used to prioritize roads identified as hydrologically connected and needing maintenance or stormproofing to decrease water quality threats. Desired conditions were identified from the watershed condition framework and professional judgement on hydrologic processes.

Existing Condition

Roads

Road indicators include road density, road maintenance, and proximity to water, and have an influence on watershed conditions. Roads affect watershed condition because more sediment is contributed to streams from roads and road maintenance than any other land management activity. Roads directly alter natural sediment and hydrologic regimes by changing the hydrologic regime (timing, magnitude, duration, and spatial distribution of runoff flows), sediment loading, transport, deposition, channel morphology and stability, and water quality and riparian conditions within a watershed.

The open road density indicator was assessed through evaluating whether the subwatershed has open road densities less than 1 mile per square mile ("good"), 1 to 2.4 miles per square mile ("fair"), or more than 2.4 miles per square mile ("poor"). Closed roads that are hydrologically connected are included in the density measurement. All three subwatersheds rated as "poor" due to the miles of road within the subwatershed (Table 2). Road density is not the most effective surrogate of road-produced water quality impacts. Recent investigations by the Umatilla National Forest have indicated that 10 percent of the road system produced 90 percent of the sediment to waterbodies. The proximity of the road to the stream and whether the road is hydrologically connected are more accurate surrogates for water quality impacts from road systems.

Table 2. Road attributes within the Camp Lick planning area

Subwatershed name	Miles of road	Miles of road within proximity to stream (percent of total roads)	Drainage area ($mile^2$)	Open road density ($miles/mile^2$)
Lick Creek	92.1	19.9 (22%)	16.4	5
Lower Camp Creek	80.3	20.7 (26%)	17	4.5
Upper Camp Creek	181.5	50.9 (28%)	29.8	5.6

Road maintenance can also increase sediment routing to streams by creating areas prone to surface runoff, altering slope stability in cut-and-fill areas, removing vegetation, and altering drainage patterns (Luce and Black 2001). The road maintenance indicator evaluates whether best management practices (BMPs) are being used for the maintenance of drainage features at 75 percent of the roads ("good"), 50 to 75 percent ("fair"), or 50 percent ("poor"). Road maintenance has been reduced across the Forest over the last 20 years due to budget constraints. Roads that are actively maintained include roads identified as minimum system roads, such as National Forest System Road 36 that is bladed annually. While these roads are considered open and hydrologically connected, they only have the potential to be hydrologically connected at stream crossing culverts. Site visits suggested that road-stream connections are not readily observed in these roads. Many arterial and collector roads do not receive road maintenance and have degrading ditch relief culverts. These failing or buried culverts are creating localized road prism safety issues and are a source of fine sediment entering into the waterbody. All three subwatersheds were ranked as "poor" for the road maintenance condition indicator due to recent activities.

Roads within 300 feet of streams have the highest potential to be hydrologically connected. Subwatersheds with less than 10 percent of the road length within 300 feet to streams are rated as "good," 10 to 25 percent are "fair," and more than 25 percent are "poor." Lick Creek was rated as "fair," with 22 percent (see Figure 1). The Upper and Lower Camp Creek subwatersheds rated as "poor." The potential for fine sediment transport and drainage efficiency alterations is heightened by the quantity of roads within proximity to streams. However, many of the roads contributing long distances within the subwatersheds are minimum system roads and have an aggregate or improved road surface, not a native road surface. Minimum system roads have been identified across the forest by USFS Engineers to receive higher levels of maintenance due to higher levels of vehicular use. This minimizes the impacts due to heightened annual maintenance of these specific roads.

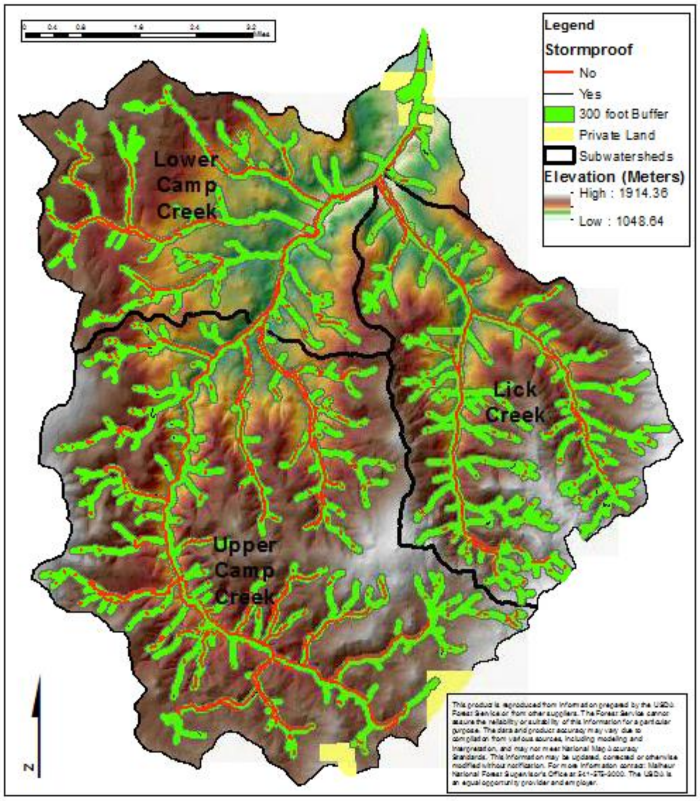

Figure 1. Camp Lick planning area hydrologically connected road status within proximity to streams

Two separate road condition surveys represent the spectrum of road conditions in the Camp Lick planning area. Most closed roads have abundant grass cover on the road prism and are resistant to erosion on the native road surface. Approximately 40 percent of road segments have had the stream crossing culverts removed and are stormproofed. A few road segments have ditch relief and stream crossing culverts that are blocked and causing rill or gulley development on the road. Some roads have ditch relief culverts spaced too far apart, or ones that are buried and causing hillslope rill or gulley erosion downhill, with a few connected directly to a stream. The biggest potential connection for sediment from roads to streams is at stream crossings and livestock trails. Many springs and seeps occur on the cutslope of the road prism within the planning area. Figures 2 through 5 provide some examples from the road condition survey report of good and bad road routes.

Figure 2. Spring in NFS Road 3600941

Figure 4. Stream crossing with culvert removed on NFS Road 3600208

Figure 3. Stream channel/gully in center of road surface on NFS Road 3640243

Figure 5. Stream captured by road and is now stream channel on NFS Road 3650631

Forest Health

Healthy forests are an important component of watershed health within the Camp Lick planning area. Insects and diseases are primary influences on forest health and are present in the Camp Lick planning area. The ability of forests to regulate water flows and maintain quality supplies is affected by the condition of the forest and the occurrence of disturbances that change the structure, composition, and pattern of forest vegetation. Forest cover is a primary terrestrial ecosystem component that is important to watershed condition. Trees provide many water- and soil-related ecosystem services such as intercepting precipitation, protecting soil, regulating snowmelt, and stabilizing steep slopes. Extensive loss of forest cover because of severe wildfires, widespread insect and disease epidemics, timber harvest, weather events, and long-term drought can effect runoff, erosion, sediment supply, bank stability, large woody debris retention, and stream temperature relationships (MacDonald et al. 1991, Meehan 1991, Reid 1993).

Within the 40,000-acre planning area, forest lands cover approximately 93 percent of the landscape. Seventy-nine percent of the forested area is overstocked, meaning that conifer stands contain higher densities of trees relative to management zones, heightening the forest’s susceptibility to crown fire. The abundance of trees due to the interruption of wildfire processes has increased vegetative transpiration rates, which contribute to reduced soil moisture and decreased grass and shrub communities within the watershed.

The structure, composition, and pattern of forest vegetation have been altered by fire suppression and past timber harvesting. As a result, hydrologic processes of snowmelt redistribution and runoff pattern, interception, evapotranspiration, infiltration, and runoff rates have been altered by these past activities. Soil mapping identified mollisol soil that was created by hundreds of years of grass plant communities, creating a dark, humus-rich surface layer. Historical wildfires for hundreds of years kept tree cover sparse in these areas and grass cover very high. Water infiltrates in a grass hillslope at higher rates because of the surface roughness provided by higher grass stem densities and because of the deeper organic matter layers. With higher tree cover, much more water is being evaporated or sublimated back to the atmosphere as opposed to reaching the ground and infiltrating. Less grass cover exists due to the shaded conditions of the tree canopy. Please see the Silviculture Report for more information on the departure from the historical range of variability for the various plant association groups that occur in the upland forested stands. Fire suppression has also allowed juniper to expand beyond its historical home range of shallow soil areas. Juniper has root systems and chemicals in its needles that outcompete grass communities from occurring in the understory and often leads to higher runoff and erosion rates with thick juniper canopies.

The condition of forest health was rated as “poor” for all three subwatersheds for watershed condition function. More than 40 percent of the area is at risk to insect and disease, tree mortality, or unhealthy stand conditions and are susceptible to wildfire. This condition has the potential to negatively affect resource values and ecosystem functions, including reducing the ability of forest canopies to intercept snow and prevent excessive runoff.

Desired Condition

Roads

The desired condition for roads is a road system that avoids disruption of natural hydrologic flow paths (PACFISH RF-2e), and roads that have water pathways that are controlled by water bars and functional drainage features. Water would spend little time on the road surface, rather, it would flow back down to the hillslope diffusely and slowly. Floods and episodic pulses of sediment would not get stuck at road crossings, but would flow freely through the stream network. Closed roads would have stream crossings removed, or waterbars placed on top of the road fill to minimize damage to the road prism and downstream aquatic habitat. Closed roads would have abundant water bars and grass seed covering the road prism. Ideally, good categories for road watershed condition indicators would be achieved over time. Roads would be consistent with resource management objectives and forest plan standards through minimizing roads located in riparian habitat conservation areas (RHCAs; PACFISH RF-2a). All three subwatersheds would have roads watershed condition class indicators that would be in a “good” functioning condition.

Forest Health

The desired condition for forest health is a landscape that is resilient to disturbance. Forest stands would be maintained over time as forests, and cover would not be lost over time due to uncharacteristic wildfire, drought, or climate change. Upland forests would be in a condition where wildfire can occur and where the structure, composition, and pattern of forest vegetation would not alter beyond its historical range of variability and would maintain high ecological integrity. All three subwatersheds would have forest health watershed condition class indicators that would be in a “good” or functioning condition. See the Silviculture Report on upland conditions for a better characterization of desired conditions for uplands.

Environmental Consequences

Methodology

The district hydrologist used multiple methods to analyze the potential effects to the subwatersheds from proposed activities. By using professional knowledge of the planning area, data collected from Level 2 Hankin and Reeves stream surveys, road condition surveys, stand exams, and Forest Vegetation Simulator (FVS) outputs, and reviewing other data and literature, the hydrologist analyzed the effects of the proposed alternatives. Alternatives were compared in terms of effects from proposed actions to hydrologic function indicators of roads and forest health. See Silviculture Report for background on FVS.

Incomplete and Unavailable Information

Road conditions surveys were completed on nearly 99 percent of all roads present in the planning area. However, there are a few road segments that were not inventoried. See Silviculture Report for information pertaining to FVS.

Spatial and Temporal Context for Effects Analysis

The analysis used a spatial extent at the 6th field Hydrologic Unit Code (HUC) subwatershed scale[1]. Lick Creek, Lower Camp Creek, and Upper Camp Creek subwatersheds were analyzed for direct, indirect, and cumulative effects. Short-term effects are defined as ranging from 1 to 4 years, unless otherwise stated. Long-term effects can last from 4 to 100s of years, depending on the processes that are impaired or at risk.

Past, Present, and Foreseeable Activities Relevant to Cumulative Effects Analysis

Past, present, and reasonably foreseeable future activities that were considered for the Watershed Report include: timber harvesting and sales; plantation maintenance; insect and disease outbreaks; past wildfire and fire suppression; beaver trapping; riparian enhancement and channel restoration; riparian plantings; range fence exlcosures; dispersed camping; hiker, horse, and foot trails; cross country off-highway vehicle (OHV) use; past, present and foreseeable livestock grazing; transportation activities; and firewood cutting. Foreseeable future actions involving the Aquatic Restoration Decision include restoration to three of the headwater wet meadows, riparian hardwood plantings and fence exclosures, beaver dam analogue construction, coarse and large woody debris placement instream, and removal of portions of the old railroad grade levee that constrains Camp Creek. Uses occurring on private lands include irrigation withdraws, livestock with stream fence exclosures, water gaps on Camp Creek, timber management, and fire suppression. The geographical scale analyzed for cumulative effects extends down to the junction of Camp Creek and the Middle Fork John Day River.

Project Design Criteria and Mitigation Measures

Table 3. Project design criteria for hydrologic function

Criteria number	Objective	Design Criteria	Areas, units, or activity type	Responsible person
Aquatic and watershed - 1	Protect aquatic resources, and follow all	See Camp Lick EA, Appendix C – Project Design Criteria for A. General Water Drafting Guidance for Road Maintenance and Non-emergency Fire Use for Watersheds with Anadromous Fish in the Blue Mountain Tri-Forest Area. B	All project activities	

[1] Hydrologic unit codes are nested within each other from large (region) to small geographical areas. The field represents the size of the drainage.

Criteria number	Objective	Design Criteria	Areas, units, or activity type	Responsible person
	applicable laws, regulations, and standards	National Marine Fisheries Service Juvenile Fish Screen Criteria for Pump Intakes C. Relevant Project Implementation Criteria for Road Maintenance Activities D. Log Haul Project Design Criteria E includes aquatic and riparian restoration programmatic consultation – Project Design Criteria for Aquatic Restoration Activities F. Key Best Management Practices.		
Aquatic and watershed -2	Minimize water quality threats.	Follow the General Water Quality Best Management Practices, Pacific Northwest Region, November 1988 (USDA Forest Service 1988) and the National Best Management Practices for Water Quality Management on National Forest System Lands, Vol. 1: National Core BMP Technical Guide (USDA Forest Service 2012). Specific BMPs for aquatics specialists applicable to this project include: T1-T22, R1-R15, R17-R23, F2-F3, VM1-VM4, RM1, and W5. Apply all applicable BMPs listed in USDA Forest Service (1988). Full descriptions of each BMP may be found in Camp Lick EA Appendix C – Project Design Criteria	All project activities	Contracting & sale administrator, aquatics specialists
Aquatic and watershed -3	Minimize equipment disturbance of duff and soil	Ephemeral stream channels should have protections to minimize equipment disturbance of duff and soil, and should not be used as skid trails, landing sites, or as road locations. Ephemeral draws (not within RHCAs) are to meet the following down wood requirements to reduce risk of upward migration and channel initiation: retain all wood embedded in the soil; retain sufficient wood for the forest type in the draw bottom for existing and future down wood. Ephemeral draws with a gradient of 5% or more will need to be visited by the hydrologist to determine if any additional site specific mitigation is required. No timber harvest within ephemeral draw buffer (10 to 50 feet on each side).	All project activities	Contracting & sale administrator
Aquatic and watershed -4	Meet PACFISH standards	Riparian habitat conservation area (RHCA) buffer widths for category 1, 2, and 4 streams (300, 150, and 100 feet on each side of the stream, respectively) and for category 3 wetlands (150 feet) shall be consistent with PACFISH.	All project activities	Contracting & layout
Aquatic and watershed -5	Protect from hazardous materials	The Forest Service will require a Hazardous Substances Plan and Prevention of Oil Spill Plan from contractor which will be reviewed and approved prior to implementation activities. Fuels and other toxicants shall not be stored within RHCAs, and other provisions of PACFISH standard RA-4 shall be implemented.	All project activities	Contracting & sale administrator
Aquatic and watershed -6	Protect from hazardous materials	Inspect all heavy equipment and machinery for hydraulic or other leaks before working near RHCAs. Leaking or faulty equipment will not be used. Equipment with accumulations of oil, grease, or other toxic materials will be cleaned in pre-approved sites outside RHCAs.	All project activities	Contracting & sale administrator
Aquatic and watershed -7	Protect aquatic resources	Industrial camping permits will be required. Locations within RHCAs will be coordinated with a Malheur National Forest aquatics specialist before permits are issued.	All project activities	Contracting & sale administrator
Aquatic and watershed -8	Meet PACFISH standards	Because streams in the aquatics analysis area are deficient in LWD in accordance with PACFISH Standard RA-2, all trees felled within or into RHCAs (including danger trees, those felled for road construction/maintenance, aspen restoration, and aquatic restoration) will either be felled into streams where feasible to provide LWD, or left within the RHCA. Felled trees may be transported off-site for use in aquatic restoration projects as determined by a Malheur National Forest aquatics specialist. Trees felled shall be pushed over with rootwad intact where feasible, rather than	All project activities	Contracting & sale administrator

Criteria number	Objective	Design Criteria	Areas, units, or activity type	Responsible person
		cutting (unless felled as part of riparian thinning treatments). This does not apply to riparian enhancement treatments, LWD could be removed in commercial units after riparian management objectives and desired conditions have been met.		
Aquatic and watershed -9	Protect RHCA resources	During implementation of upland silviculture treatments do not use heavy equipment in RHCAs and do not use off road vehicles within 100 feet of streams, springs, or wetlands.	Upland silviculture activities	Contracting & sale administrator
Aquatic and watershed -10	Meet PACFISH standards	Follow PACFISH standards and guidelines. Timber management, roads management, and fire/fuels management standards and guides apply to this project.	All activities in RHCAs	Contracting & sale administrator
Aquatic and watershed -11	Meet PACFISH standards	No yarding of logs will occur within existing meadow areas, only around the edge.		
Aquatic and watershed -12	Protect aquatic resources	The work period for instream work, including culvert installations on fish-bearing streams, will be July 15 through August 15, as specified in the Oregon Guidelines for Timing of In-Water Work to Protect Fish and Wildlife Resources, June 2008.	Culvert installation road decommissioning	Engineer, or contracting
Aquatic and watershed -13	Prevent erosion and runoff	Conduct activities during dry-field conditions – low to moderate soil moisture levels.	Culvert installation road decommissioning	Engineer, or contracting & sale administrator
Aquatic and watershed -14	Meet all applicable standards	Culvert installation and road decommissioning would will be completed in accordance with the Regional General Permit issued by the U.S. Army Corps of Engineers. Minimization measures for fisheries, watershed function, water quality, and soil conditions include those identified in the NMFS and FWS 2013 ARBO II as well as PDCs developed by the Blue Mountain Ranger District interdisciplinary team. A complete listing of ARBO II PDCs specific to this project element is included in Camp Lick EA, Appendix C – Project Design Criteria.	Culvert installation road decommissioning	Engineer, or contracting & sale administrator
Aquatic and watershed -15	Meet PACFISH standards	All quality pools (pools greater than 2 feet in depth or pools greater than 1.5 feet in depth with cover) will be noted and designed for retention within the planning area.	Culvert installation	Engineer, or contracting
Aquatic and watershed -16	Meet water quality standards	There should be no measureable loss in streamside shade within the project area from culvert replacement/installation on fish bearing streams. If a measurable reduction in stream shade cannot be avoided, the project will be designed to obtain recovery of streamside shade within an approximate five year period, including the use of riparian plantings.	Culvert installation	Engineer, or contracting
Aquatic and watershed -17	Prevent erosion	In RHCAs or ephemeral draws, conduct culvert installation, replacement or removal during dry conditions or with approval from the district hydrologist and fish biologist. Prevent erosion of soil into streams during installation using appropriate BMPs (Camp Lick EA, Appendix C – Project Design Criteria). Cease work if a storm event increases stream flows.	Culvert installation	Engineer, or contracting, district hydrologist and fish biologist
Aquatic and watershed -18	Protect watershed resources	Grapple/hand piling areas will not be located within RHCAs, except for aquatic restoration projects designed for RHCAs.	Prescribed burning	Burn boss, COR

Criteria number	Objective	Design Criteria	Areas, units, or activity type	Responsible person
Aquatic and watershed -19	Restore forest resiliency	Ignition of underburning may occur in RHCAs, and may occur up to 25 feet from the edge of the stream channel (to prevent drip torch fuel from entering the stream). Fire will be allowed to back into the riparian areas.	Prescribed burning	Burn boss
Aquatic and watershed -20	Protect watershed resources	Firelines will not be constructed within RHCAs and will be waterbarred on slopes greater than 35%. Firelines will utilize existing constructed and natural barriers such as existing roads and streams, and will be rehabilitated to a natural state after use. Fireline construction will not occur down draw bottoms. Hand lines may be used to keep fire out of sensitive areas and private property.	Prescribed burning	Burn boss
Aquatic and watershed -21	Maintain water quality	There should be no measureable loss in streamside shade within the project area from fence construction on fishbearing streams. If a measurable reduction in stream shade cannot be avoided, the project will be designed to obtain recovery of streamside shade within an approximate five year period, including the use of riparian plantings.	Range activities	Rangeland manager
Aquatic and watershed -22	Protect riparian hardwoods	Minimize disturbances to riparian hardwoods greater than 2 feet in height located within the floodplain or providing bank stabilization. Consider cutting hardwoods at their base where equipment crossings are needed. This will encourage re-sprouting at a faster rate.	Riparian restoration activities	Contracting & sale administrator
Aquatic and watershed -23	Protect watershed resources	Obtain approval from district fisheries biologist and hydrologist on specific methods for removing culverts from streams.	Road decommissi oning	Engineer, or contracting & sale administrator
Aquatic and watershed -24	Erosion control	Decommission roads by some combination of the following: recontouring slopes (removing cut and fill slopes); subsoiling (loosening) compacted soils in a "J" pattern to a depth of 16 inches (unless prevented by bedrock or rock content of soils); pulling berm; pulling slash (where available); planting or seeding disturbed areas with native species that naturally occur in the project planning area to achieve a minimum of 35% ground cover; restoring natural drainage patterns and waterbarring as needed; and/or disguising the first hundred yards of travel way with large pieces of organic material such as cull logs and tops of trees. Methods will be determined in consultation with a hydrologist, fisheries biologist, or soil scientist.	Road decommissi oning	Engineer, or contracting & sale administrator
Aquatic and watershed -25	Erosion control	Utilize erosion control measures (sediment filters or straw bales) and operate machinery only on road prism during road construction, maintenance and road decommissioning activities.	Road maintenance , decommissi oning and new road construction	Engineer, or contracting & sale administrator
Aquatic and watershed -26	Erosion control	Locate temporary roads outside sediment delivery zones (determined by soil type, ground vegetation, and slope), meet best management practices for controlling surface runoff and erosion, and keep machinery on approved roadway.	Temporary road and landing construction	Engineer, or contracting & sale administrator
Aquatic and watershed -27	Erosion control and wildlife habitat preservation	Obliterate temporary roads by some combination of the following: recontouring slopes (removing cut and fill slopes); subsoiling (loosening) compacted soils in a "J" pattern to a depth of 16 inches (unless prevented by bedrock or rock content of soils); pulling berm; pulling slash (where available); planting or seeding disturbed areas with native species that naturally occur in the project planning area to achieve a minimum of 35% ground cover; restoring natural	Temporary road and landing construction	Engineer, or contracting & sale administrator

Criteria number	Objective	Design Criteria	Areas, units, or activity type	Responsible person
		drainage patterns and waterbarring as needed; and/or disguising the first hundred yards of travel way with large pieces of organic material such as cull logs and tops of trees. Methods will be determined in consultation with a hydrologist, fisheries biologist, wildlife biologist, or soil scientist.		
Aquatic and watershed -28	Erosion control	Landings/staging areas will not be located within riparian habitat conservation areas (RHCAs) unless located on existing landings or utilizing an area approved by the Aquatics Staff.	Landings	Timber sale administrator, Aquatics Staff
Aquatic and watershed -29	Erosion control	Minimize amount of blading on closed roads with good grass cover present, unless a gulley or safety is present.	Timber haul	Timber sale administrator
Aquatic and watershed -30	Protection of watershed resources	Timber harvest will not occur within RHCAs, unless identified as an aquatic restoration unit.	Timber felling	Timber sale administrator, layout
Aquatic and watershed -31	Forest restoration, protection of watershed resources	Skyline yarding corridors (sky roads) and tailholds are permitted across streams. Corridors must be less than 12 feet wide, spaced greater than 100 feet apart when crossing the stream, as close to perpendicular to the channel as possible, and can range from 350 to 1000 feet in length.	Timber yarding	Timber sale administrator
Aquatic and watershed -32	Protection of watershed resources	Require one end suspension on >90% of skyline logging corridors. Logs will be fully suspended over streams.	Timber yarding	Timber sale administrator
Aquatic and watershed -33	Protection of watershed resources	Heavy equipment is permitted only at designated crossings within the ephemeral draws and stream channels, and approved by a hydrologist or fisheries biologist.	Timber yarding	Timber sale administrator, layout
Aquatic and watershed -34	Protection of watershed resources	Skyline corridors shall be oriented perpendicular across ephemeral draws, not running lengthways along them.	Timber yarding	Timber sale administrator
Aquatic and watershed -35	Protection of watershed resources	No skidding will occur across stream channels (categories 1-4), unless approved by aquatics staff. Logs and slash would be placed at all crossings within channel and floodplain to minimize soil compaction. Once skidding is complete, logs and slash will be spread out across channel and floodplain to minimize bare ground and maintain water quality.	Timber yarding	Timber sale administrator, aquatics staff

Alternative 1 – No Action

Direct and Indirect Effects

Roads

Implementation of the no action alternative would maintain road conditions that are hydrologically predominantly connected to the stream network. Ditches on roads would continue to intercept surface and/or subsurface runoff and route the water to the streams more efficiently. There would be no change to the miles of road stormproofed within the planning area.

Culverts would continue to have a hydraulic impact to the stream network and influence sediment and water transport rates through the pipe. The effect of an undersized culvert creates a backwatered condition upstream of the culvert and decreases sediment transport. The road prism associated with a buried culvert may be a source of fine sediment to waterbodies and pose a safety problem for vehicular travel. Fine sediment from road prisms could degrade water quality in depositional reaches into the future if not stormproofed. Other segments of road are stable and would not affect stream channels. There are a total of 91.5 miles of road within proximity to streams (300 feet on either side of stream) that may continue to route water off the landscape faster and affect stream channels with road/stream sediment connections.

No road maintenance, changes in road status, or road decommissioning would occur as part of the no action alternative. Roads would stay in their “poor” condition classes for hydrologically connected road density, road maintenance, and hydrologically connected within proximity to stream road density indicators (see Table 4 and Table 5). The no action alternative is inconsistent with the purpose and need of the Camp Lick Project and the Malheur Forest Plan, as amended.

Table 4. Stormproof road status by subwatershed, percent of road stormproofed, and open road density for the no action alternative within the Camp Lick planning area

Subwatershed stormproof road status	Miles of road	Percent of road stormproofed	Open road density (miles per square mile)
Lick Creek total	92.1	0%	16.4
Lick Creek not stormproofed	82.8	90%	5.0
Lick Creek stormproofed	9.3	10%	0
Lower Camp Creek total	80.3	0%	17.0
Lower Camp Creek not stormproofed	76.8	96%	4.5
Lower Camp Creek stormproofed	3.5	4%	0
Upper Camp Creek total	181.5	0%	29.8
Upper Camp Creek not stormproofed	167.5	92%	5.6
Upper Camp Creek stormproofed	14.1	8%	0

Table 5. Strormproof road status by subwatershed for roads within proximity to streams (300 feet), percent of road stormproofed, and open road density for the no action alternative within the Camp Lick planning area

Stormproof road status	Miles of road within 300 feet of stream	Percent of road stormproofed within 300 feet of stream	Percent of road within 300 feet from total road length
Lick Creek total	20.4	0%	0
Lick Creek not stormproofed	19.9	98%	22%
Lick Creek stormproofed	0.4	2%	0
Lower Camp Creek total	20.9	0%	0
Lower Camp Creek not stormproofed	20.7	99%	26%
Lower Camp Creek stormproofed	0.2	1%	0
Upper Camp Creek total	52.1	0%	0
Upper Camp Creek not stormproofed	50.9	98%	28%
Upper Camp Creek stormproofed	1.2	2%	0

Forest Health

Implementation of the no action alternative would maintain managed timber stands that are outside of their historical range of variability for density, structure, and species composition on their current trajectory. More stands would gradually move outside of their range as time progresses. Fully stocked stands would continue to undergo reduced growth rates due to competition for available water in the warm and hot plant association groups. Interception (the capture of snow on trees) and sublimation rates (evaporation of snow) would increase in higher density stands and work to decrease infiltration and ultimately, late season baseflows. There would be an increased risk for insect outbreaks. Insect outbreaks may increase in severity and extent. This could make the forest subject to a high-severity wildfire (see Fire, Fuels, and Air Quality Report). Climatic droughts could add to the effects of overstocked stands and insect issues.

Over-dense stands in valley bottoms or around meadows with elevated water tables may be increasing the evapotranspiration losses that are decreasing baseflows at the highest rate. If a high-severity wildfire were to occur, larger areas may be burnt, with more intensity and higher rates of vegetative mortality than was seen historically. Under this high-severity wildfire scenario, a drastic reduction in the amount of transpiration could occur until vegetative recovery takes place in 5 to 10 years, depending on the elevation and growth rates. This could lead to higher peak flows occurring earlier in the season with increased base flows for that time period. Forest health condition for all three subwatersheds under the no action alternative would remain poor and be departed from the historical range of variability.

Cumulative Effects

Roads and Forest Health

Under the no action alternative, there would be no management activities associated with timber harvest, prescribed fire and unplanned ignitions, fence construction, recreation interpretive site development, and associated road activities in the planning area; therefore, there would be no direct or indirect effects to roads and forest health watershed condition indicators, or hydrologic function. There would continue to be ongoing effects from the past, present, and reasonably foreseeable future actions.

The hazard of an uncharacteristic fire would remain high, as described in the fuels section of the Camp Lick EA chapter 3. Most of the forested stands in both riparian areas and the uplands within the planning area are overstocked and have been identified as moderate to high risk for insect and disease mortality and crown fire. Without silvicultural treatment and/or the controlled re-introduction of fire into the planning area, current stand conditions would worsen and increase the chance of a stand replacing fire. A stand replacing wildfire would result in the loss of shading along stream channels, loss of instream wood structures, and short-term (5 to 10 years) loss of streamside vegetation, depending on the vigor of riparian hardwoods. Water temperatures would increase for perhaps one to a few decades, depending on riparian shrub and tree recovery. Sediment from upland sources could increase for one to three years following a fire. Sediment from channel sources could increase due to higher peak flows and loss of stabilizing trees and shrubs. There would be increased sediment from channel sources for approximately five years until bank stabilizing vegetation has recovered. The sediment could be at a spatial scale that would be larger than what our historical wildfire regime would have historically produced. Severe fire would also supply an extended pulse of woody debris to streams, which would gradually decay over decades. The largest issue with this is that vegetation mortality would occur at larger scales than was seen historically and the potential exists to have debris flows from gulley erosion occur in multiple tributaries at the same time. The higher bedload rates associated with gulley erosion at these larger scales could be detrimental to fish. Restoration could occur to the meadow riparian reaches, but if the upland conditions do not provide water that is suitable, it would not be good habitat.

A lack of road maintenance or relocation of roads in poor condition may cause road drainage structures and the road prism to fail. This has the potential to increase the risk to water quality and aquatic biota.

The effects from past practices (which include timber harvesting, fire suppression, livestock grazing, road construction, wildfire, and beaver trapping) have created stream channels and meadows that are incised and lack floodplain connectivity across the planning area. Taking no action to remove valley bottom or problematic roads, or reduce upland tree densities, would keep watershed hydrologic conditions departed from desired future conditions. The hydrologic recovery of roads and forest health would be a slow process, because of the effects of past management practices creating detrimental conditions for disturbances like drought and wildfire.

Alternative 2 – Proposed Action

Direct and Indirect Effects – Silviculture Treatments, Riparian and Upland Watershed Restoration Treatments, Fire Treatments, Range Fence

Roads

Implementing the silviculture treatments, riparian and upland watershed restoration treatments, fire treatments and range fence are not analyzed in the roads section below, because there will be no direct or indirect effects to roads from these activities. However, silviculture treatments will use road activities for haul and will be discussed below.

Direct and Indirect Effects – Road Activities and Interpretive Sign Installation

Roads

Implementing the road activities of road use (defined as maintenance for haul on open and closed roads, temporary road construction, and gravel pit development), road system changes (open roads becoming closed or decommissioned or closed roads opening), stormproofing, and confirmation of road closures have the potential to have direct and indirect effects affecting ground cover and runoff patterns that may impact hydrologic function resource elements. Altering ground cover and runoff patterns can influence fine sediment inputs reaching waterbodies.

Proposed road activities have the largest potential direct and indirect effects that may influence fine sediment. During pre-haul, native surface roads would be bladed to remove water bars and holes in the road for log haul safety. Blading the road disturbs the road surface, altering ground cover and allowing fine sediment to be more readily available for transport to a nearby waterbody. The aquatic and watershed project design criteria-29 was designed to minimize blading on specific native surface roads close to the stream network where grass cover is present and haul can be accomplished safely. This project design criteria (PDC) is expected to minimize the amount of bare surface roads adjacent to waterbodies. Leaving grass would filter fine sediment erosion on the road surface.

Stream crossings and native surface roads within 300 feet to streams have a natural, inherent potential to be a source of fine sediment to the waterbody during haul. There would be 70.2 miles of haul on native surface roads within 300 feet of streams. These road segments have the greatest likelihood of altering runoff patterns and delivering fine sediment to waterbodies. As a result, project design criteria have been developed for the project to mitigate these potential effects. All native surface roads that have a category 1 or 2 stream crossing would be evaluated for rocking the crossing with aggregate rock. Closed native surface roads that have long segments within riparian habitat conservation areas would have higher densities of water bars constructed in their road prism when activities have been completed. Section D of the aquatic and watershed project design criteria would add coarse wood downstream of identified native surface roads that cross category 4 streams, to control sediment runoff. These projects are targeted at controlling fine sediment from haul on native surface roads through the use of best management practices (BMPs) and project design criteria. The expected effects through implementing project design criteria are to mitigate effects of sedimentation to water bodies from the proposed action and to maintain water quality standards.

There are approximately 10 miles of temporary roads proposed. Implementing temporary road construction on approximately 10 miles of road has the potential to have direct and indirect effects that could expose ground cover and soil for 3 to 5 years until native grass seed provides cover. One temporary roads is located in a riparian habitat conservation area (RHCA). The temporary road has approximately 200 feet located within a category 1 stream, West Fork Lick Creek, and approximately 520 feet in a category 4 stream. Temporary roads will be obliterated after use, unless they are established on an old road prism and will be left in a similar condition. Disturbance would occur at gravel pits providing rock for road surfacing and improvements. Existing sources would be used in the planning area.

Road system changes (open roads becoming closed or decommissioned or closed roads opening) have the potential to impact road watershed condition indicators and hydrologic function. Closing 25.8 miles of open roads would allow more road segments to be hydrologically disconnected and stormproofed through adding more water bars and drainage dips. This project would also ensure all closed roads are properly stormproofed and that they receive needed maintenance. Table 6 and Table 7 below illustrate the magnitude and direction of change through implementation of stormproofing and road system changes. The proposed action would open 3.8 miles of road from a closed road status. These road segments were identified as being already hydrologically connected, so these would not meaningfully contribute to hydrological function indicators. Approximately 4.16 miles of road would be decommissioned and hydrologically disconnected; 2.1 miles of these decommissioned roads occur in RHCAs and likely have the greatest impact on hydrologic function from the roads proposed for decommissioning.

Road decommissioning has the potential to have direct and indirect effects that could expose ground cover and soil for 1 to 3 years until native grass seed provides cover. Road decommissioning would follow an Aquatic Restoration Biological Opinion and Watershed PDC to control erosion from these activities and to minimize impacts. Examples of the PDCs designed to control erosion include:

- Conduct activities during dry-field conditions with low to moderate soil moisture levels.
- Obtain approval from aquatics staff on specific methods for removing instream culverts and implement during instream window if on perennial channel.
- Utilize sediment filters or straw bales to control erosion.

Stormproofing the closed road system after road haul would help disconnect any hydrologic connections that may form, particularly to roads within proximity to streams (Table 6). This would happen through minimizing the time water spends on the road prism by constructing frequent water bars and drainage dips. Stream crossing culverts would be removed on identified roads unless fills of greater than 4 feet are present. If more than 4 feet of fill is present, a dip would be placed if needed to minimize drainage diversions.

Table 6. Miles of stormproofed road within proximity to streams (within 300 feet), percent of total road miles, and total miles of road within the planning area for alternatives 1 and 2

Subwatershed road status	Miles of road within 300 feet[1]	Percent of road within 300 feet[1]	Percent of road within 300 feet from total road length[1]	Miles of road within 300 feet[2]	Percent of road within 300 feet[2]	Percent of road within 300 feet from total road length[2]
Lick Creek total	20.4	0%	0%	20.4	0%	0

Subwatershed road status	Miles of road within 300 feet[1]	Percent of road within 300 feet[1]	Percent of road within 300 feet from total road length[1]	Miles of road within 300 feet[2]	Percent of road within 300 feet[2]	Percent of road within 300 feet from total road length[2]
Lick Creek not stormproofed	19.9	98%	22%	13.0	64%	14%
Lick Creek stormproofed	0.4	2%	0%	7.3	36%	0%
Lower Camp Creek total	20.9	0%	0%	20.9	0%	0%
Lower Camp Creek not stormproofed	20.7	99%	26%	12.0	58%	15%
Lower Camp Creek stormproofed	0.2	1%	0%	8.9	42%	0%
Upper Camp Creek total	52.1	0%	0%	52.1	0%	0%
Upper Camp Creek not stormproofed	50.9	98%	28%	27.5	53%	15%
Upper Camp Creek stormproofed	1.2	2%	0%	24.6	47%	0%

[1] No action alternative

[2] Proposed action

Table 7. Miles of stormproofed road within the planning area, percent of total road miles, and total miles of road within the planning area for alternatives 1 and 2

Subwatershed road status	Miles of road[1]	Percent of road stormproofed[1]	Open road density[1]	Miles of road[2]	Percent of road stormproofed[2]	Open road density[2]
Lick Creek total	92.1	0	16.4	92.1	0	16.4
Lick Creek not stormproofed	82.8	90%	5.0	41.7	45%	2.5
Lick Creek stormproofed	9.3	10%	0	50.4	55%	0
Lower Camp Creek total	80.3	0	17.0	80.3	0	17.0
Lower Camp Creek not stormproofed	76.8	96%	4.5	36.8	46%	2.2
Lower Camp Creek stormproofed	3.5	4%	0	43.5	54%	0
Upper Camp Creek total	181.5	0	29.8	181.5	0	29.8
Upper Camp Creek not stormproofed	167.5	92%	5.6	90.9	50%	3.1
Upper Camp Creek stormproofed	14.1	8%	0	90.6	50%	0

[1] No action alternative

[2] Proposed action

Alternative 2 would administratively close roads that are identified as being closed in the Infrastructure database (Infra), but this would not affect Watershed resources as these closures are procedural in nature.

The proposed action would place the road proximity to streams indicator on a trajectory more in line with desired conditions, the purpose and need statement (managing for resource management objectives), and forest plan standards. That would be an improvement from a "poor" existing condition. Roads would be in a stable condition and there would be minimal impacts if a wildfire or a flood disturbance occurred. The Lower Camp Creek subwatershed would be improved to a “fair, functioning at risk” condition for open road density. The other two subwatersheds would remain in a “poor” condition, despite reducing road density from 5 to 2.5 miles per square mile and 5.6 to 3.1 miles per square mile. All three subwatersheds would be moving towards desired conditions for this indicator. Road maintenance would have BMPs applied to all roads being treated and would be good for all three subwatersheds. More importantly, roads that are within proximity to water would also improve towards desired conditions. The Lick Creek subwatershed was rated “at risk” and would remain “at risk," but hydrologically connected roads within 300 feet of a stream would be reduced from 22 to 14 percent. The Lower Camp Creek and Upper Camp Creek subwatersheds would both change from “impaired” to “at risk,” reducing from 26 to 15 percent and 28 to 15 percent, respectively. This is an important reduction of road segments that may pose a risk to water quality impacts in the long-term.

Direct and Indirect Effects – Riparian and Upland Watershed Restoration Treatments, Interpretive Sign Installation, Range Fence, and Road Activities

Forest Health

Implementing the interpretive sign installation, range fence and road activities are not analyzed in the forest health section below, because there will not be do direct or indirect effects to forest health from these activities. However, riparian and upland watershed restoration treatments will have direct or indirect effects to forest health, but will be discussed in the riparian function section.

Direct and Indirect Effects – Silviculture Activities, Fire Treatments

Forest Health

Implementing the silviculture activities of stand improvement commercial thinning (8,700 acres), lodgepole treatments (600 acres), stand improvement biomass thinning (2,250 acres), western white pine restoration (150 acres), juniper encroachment treatments (730 acres), and biomass removal would cause direct and indirect effects that may impact hydrologic function. Treatments may impact hydrologic function by: altered infiltration rates and overland flow from changes in ground cover; reduced tree densities altering interception and sublimation rates; gaps in tree spacing to alter snow accumulation and redistribution patterns; reduced densities and species composition decreasing the evapotranspiration rates; and increased soil moisture durations for understory grass and shrub communities.

The scale of silvicultural treatments is approximately 12,430 acres. This is approximately 34 percent of the 40,000-acre planning area that would be affected. The existing condition identifies that 79 percent of treatment units are in an overstocked condition and are susceptible to a crown fire, which is departed for these management zones. Table 8 shows the amount of silviculture treatments proposed for each subwatershed in the planning area. The proposed treatments would improve the upland vegetative characteristics so they are more resilient and less susceptible to drought, wildfire, insects, and disease stressors.

Table 8. Subwatersheds with proposed treatment area, watershed area and percent of watershed treated for the planning area

Subwatershed	Proposed treatment area (acres)	Watershed area (acres)	Percent of watershed treated
Lick Creek	2,330	10,470	22%
Lower Camp Creek	5,063	10,864	47%
Upper Camp Creek	6,071	19,076	32%

Stand treatments would promote variable density within and among stands, RHCAs, by leaving skips, varying thinning intensities, and introducing gaps in selected stands (see the Silviculture Report). Treatments were identified in stands that have tree densities that are creating unhealthy conditions, or where fire suppression has altered the species composition towards having more late seral species than would have been present historically.

In areas where vegetation is cleared for landing zones and skid trails, minor amounts of erosion and overland flow would occur, especially on hillslopes. Overland flow is expected to infiltrate within unit boundaries since ground cover would be maintained over most of the area. Although sediment may be detached where mineral soil is exposed within harvest units, it is likely to be trapped by ground cover and is unlikely to be transported beyond unit boundaries. Restoring the density and structure of the forest would increase the gaps or area for snow to accumulate and slowly percolate into the soil profile. Snow accumulated on the canopy of a tree may be returned to the atmosphere in a process known as interception and sublimation. When the forest is overly dense, it may result in less water reaching the ground and infiltrating into the soil profile. A less dense forest redistributes the snow into larger accumulations that benefit infiltration. This contributes to higher inputs of groundwater that eventually provide late season streamflow called baseflows.

The effect to soil moisture from the removal of trees would likely be different for the various plant association groups that exist. Water is the limiting factor for achieving the carrying capacity for Warm Dry (or Hot Dry) plant association groups. In these warm plant association groups, the portion of water that is lost to transpiration would likely be redistributed to the understory (shrub and grass components) after the proposed action. Energy (e.g., light and nutrients) is the limiting factor for Cool and Cold Moist plant association groups. Treatments in the cool and cold plant association groups may provide for longer soil moisture durations.

Under alternative 2, the most likely effect to overall forest health (influencing hydrologic function) from yarding and landings on hillslopes and ephemeral swales is little or no change when individual units are considered, because BMPs and design criteria (see EA Appendix C – Project Design Criteria) are expected to control most runoff and sediment transport under common run-off events.

The Soil Report indicates that detrimental impacts in most tractor yarding units are expected to increase from the current condition (commonly, 0 to 8 percent of the unit area) to 6 to 14 percent of the unit area, depending on the specific unit. Minor amounts of erosion (see Soil Report) and overland flow may be generated within units during runoff events. Overland flow is expected to infiltrate within unit boundaries since ground cover would be maintained or improved over most of the area. Although sediment may be detached where mineral soil is exposed within harvest units, it is likely to be trapped by ground cover and unlikely to be transported beyond unit boundaries.

Some units are located on hillslopes in sub-drainages which have been previously disturbed by management activities, increasing the chance that impacts from previous disturbance would become connected to ground disturbance associated with the proposed actions. This could possibly extend the drainage network to higher elevations or create concentrations of runoff or sediment that could be transported beyond unit boundaries during large, rare runoff events. However, generally overland flow is not expected to be concentrated enough to cause accelerated erosion, or to deliver increased sediment to live streams in most locations under common rainfall events.

Prescribed burning in upland stands is expected to reduce heavy fuels. Managing for unplanned ignitions would allow improvements to stand conditions over time. Underburning would occur on up to approximately 32,000 acres. Pile burning would minimize fuel accumulations on approximately 6,200 acres. Mastication would thin stand densities and create additional ground cover through wood mulch.

Wood mulch on the ground surface would increase infiltration and slow runoff in areas with poorer soils. Prescribed burning in RHCAs is not expected to expose mineral soil because it would burn with low intensity and severity as described in the design criteria listed in the Camp Lick EA Appendix C – Project Design Criteria. Low intensity fire is not expected to fully consume organic matter on the soil surface. Low intensity fire is not expected to burn wetter riparian vegetation, as fire would likely die out in the inner RHCAs. Consequently, prescribed burning is not expected to detrimentally affect forest health nor hydrologic functions. Managing unplanned ignitions would allow acres to be treated if weather, fuels, and firefighter safety conditions are met.

The proposed action would place the forest health condition on a trajectory towards being "good" and in alignment with desired conditions. That would be an improvement from the current "fair" condition rating. Upland forests would be more resilient to wildfire, drought, insect, and disease disturbances.

Cumulative Effects

Roads and Forest Health

Past, present, and reasonably foreseeable future activities that were considered for the Watershed Report include: timber harvesting and sales; plantation maintenance; insect and disease outbreaks; past wildfire and fire suppression; riparian enhancement and channel restoration; riparian plantings; range fence exclosures; dispersed camping; hiker, horse, and foot trails; cross country OHV use; past, present and foreseeable livestock grazing; transportation activities; and firewood cutting. Foreseeable future actions involving the Aquatic Restoration Decision include restoration to three headwater wet meadows, riparian hardwood plantings, fence exclosures, beaver dam analogue construction, coarse and large woody debris placement instream, and removal of portions of an old railroad grade levee that constrains Camp Creek. Uses occurring on private lands include irrigation withdrawals, livestock with stream fence exclosures, water gaps on Camp Creek, timber management, and fire suppression. The geographical scale analyzed for cumulative effects extends down to the junction of Camp Creek and the Middle Fork John Day River.

Direct or indirect adverse effects from the proposed silvicultural treatments are expected to remain within unit boundaries, and adverse cumulative effects from the proposed activities are not expected during common runoff events. Increased disturbed hydrologic connections may contribute to accelerated erosion over larger areas. Additional ground cover from slash and seed would be applied to all disturbance paths in riparian habitat conservation areas. Within 5 years of project activity, additional flows and sediment may reach the Middle Fork John Day River following rare high flow run-off events. However, increases in run-off would not be measurable compared with the magnitude of the response under alternative 1 and the variability associated with measuring watershed attributes.

Modifying vegetation and other conditions influencing fire behavior in the planning area may reduce fire intensity as described in the Fire, Fuels, and Air Quality Report and improve watershed resiliency in adjacent areas. Fire behavior is expected to change from uncharacteristically high to characteristically low intensity; ground disturbance effects from either uncharacteristic wildfire itself or suppression activities are expected to be reduced. Consequently, cumulative interactions between these effects and those of legacy disturbances are expected to be reduced, resulting in a reduction in watershed hazard.

Implementing proposed upland silvicultural treatments on approximately 12,430 acres would move the upland stands towards their historical range of variability and reduce cumulative effects by restoring physical processes and ecological functions. Road stormproofing and decommissioning would also improve hillslope and stream network hydrologic flowpaths and decrease the potential for future water quality issues.

These projects, combined with past watershed restoration projects in other locations in the cumulative effects analysis area, would contribute to the cumulative recovery of the Lower Camp Creek, Upper Camp Creek, and Lick Creek subwatersheds. The majority of road conditions would still be in a "fair, functioning at risk" condition, but they would be improved from the existing condition. Forest health would also be in "good" condition following treatments. The hydrologic function would be increased through implementation of the proposed action, taking into account the cumulative effects of other activities in the area.

Compliance with Forest Plan and Other Relevant Laws, Regulations, and Policies

Forest Plan

This project is consistent with Malheur Forest Plan direction for water resource protection because it would not measurably increase watershed impacts, including stream temperature, over the existing conditions at the 6th field scale. The "Forest Service R6 General Water Quality Best Management Practices" (USDA Forest Service 1988) would be followed under alternative 2. Interim Strategies of Managing Anadromous Fish Producing Watersheds (PACFISH) standards and guidelines, and Malheur Forest Plan standards that provide direction for riparian buffers would be used. For this analysis, Management Area 3B is described through the term riparian habitat conservation area (RHCA) because RHCAs are wider and more conservative.

Additional Malheur Forest Plan and PACFISH standards and guidelines are discussed below:

- Associated road treatments are consistent with the Malheur Forest Plan, PACFISH Road Management -2 (RF-2) b: minimizing road and landing locations in RHCAs. This standard and guideline would be met for alternative 2 because roads within RHCAs were considered for long-term management, fire, timber, and recreational access needs or uses and their resource impacts. Approximately 2.1 miles of road located within RHCAs would be decommissioned and the road prism would be removed from the RHCAs. Many other road segments would receive stormproofing or road reconstruction with the proposed action and would be hydrologically disconnected from the stream network. Alternative 1 would not contribute towards meeting riparian management objectives (RMOs) because these RHCA roads would remain in their present condition.
- Riparian restoration treatments are consistent with the Malheur Forest Plan, PACFISH Watershed and Habitat Restoration – 1 (WR-1): Design and implement watershed restoration projects in a manner that promotes the long-term ecological integrity of ecosystems, conserves the genetic integrity of native species, and contributes to attainment of RMOs. This standard and guideline would be met for alternative 2 because the design is being focused on the physical processes that need to be restored to allow long-term functions to occur. Alternative 1 would not contribute towards meeting RMOs.

Clean Water Act

This project is consistent with the Clean Water Act and Forest Service responsibilities under the Clean Water Act as described in a Memorandum of Understanding (MOU) with the Oregon Department of Environmental Quality (USDA Forest Service 2014) because it would not impact stream temperature. The MOU also directs that the Forest Service cannot further degrade water quality impaired streams, although short-term adverse impacts which occur with long-term benefits are allowed. Several streams in the planning area were on the Oregon 303(d) list for above normal stream temperatures, prior to development of the Total Maximum Daily Load (TMDL). All alternatives comply with the Clean Water Act, since none would raise stream temperatures, and since all would follow Best Management Practices as specified in "Forest Service R6 General Water Quality Best Management Practices" (USDA Forest Service 1988) and

"National Best Management Practices for Water Quality Management on National Forest System Lands" (USDA Forest Service 2012).

The Forest Service is directed to comply with State requirements in accordance with the Clean Water Act for protection of waters of the State of Oregon (OAR chapter 34041) through planning, application, and monitoring of best management practices (BMPs), which are recognized as the primary means to control non-point source pollution on National Forest lands. BMPs would be monitored by the Blue Mountain Ranger District hydrologists, fish biologists, timber sale administrators, and harvest inspectors. The MOU also directs that the Forest Service cannot further degrade water quality impaired streams.

There is uncertainty whether a National Pollution Discharge Elimination System (NPDES) permit would be required for stormwater discharges from logging roads. Implementation of BMP monitoring to ensure BMPs and project design criteria are being properly implemented should provide direction that NPDES requirements are being met.

Floodplains (Executive Order 11988)

Executive Order 11988 states that Federal agencies shall avoid adverse effects to floodplains or minimize potential harm. Floodplains several to hundreds of feet wide occur in the planning area. These floodplains are primarily contained within RHCAs. The proposed implementation activities would improve the physical processes of floodplain connectivity and floodplain functions of water storage through being inundated. The proposed action would not have any actions that would adversely affect floodplains, and thus would be consistent with Executive Order 11988.

Wetlands

Executive Order 11990 states that Federal agencies shall avoid management practices that would adversely affect wetlands. Wetlands that occur in the planning area would be maintained, improved, and expanded in spatial extent with improved function. Decommissioned roads would be removed from valley bottoms. This project is consistent with the Executive Order protecting Wetlands.

Monitoring

Best Management Practice (BMP) monitoring would occur to ensure design criteria and BMPs are being utilized. Methods would be following the USFS National Best Management Practices for Water Quality Management (USDA Forest Service 2012).

Riparian Function

Affected Environment

Methodology

The methodology for assessing the riparian function condition was completed through evaluating site specific data collected during the 2014 to 2016 field seasons, and evaluating indicators in the watershed condition classification system, Forest Vegetative Simulator (FVW; generated by project silviculturist), and from using the program NetMap. Data collected in the field for riparian function included Region 6, Level 2 Hankin and Reeves Stream Surveys, laser surveyed cross sections of Camp Creek, stand exams, and field site visits. Level 2 stream surveys were used to provide existing conditions for riparian shade conditions, stream channel shape and function conditions, and large woody debris instream conditions. Watershed condition classification indicators were used to characterize the condition of the resource. NetMap was used to spatially illustrate sediment process domains (source, transport, and depositional zones) and for understanding stream classifications in the stream network based on channel slope. NetMap was used to assess shading functions from riparian canopies and for assessing where shade was most at risk if tree crowns were consumed by a wildfire. NetMap was also used to identify where hillslopes and ephemeral draws are inherently most active erosionally, including the portion of the stream network that is prone to gullying or debris flows. Stand exam plots were established in both riparian and upland stands. Desired conditions were acquired from Malheur Forest Plan Standards and the Total Maximum Daily Load (TMDL) assessment for the John Day River Basin.

Existing Condition

Riparian and wetland areas in the Camp Lick planning area are the interface between terrestrial and aquatic ecosystems and are an integral part of the watersheds. Consequently, the health of these areas is closely interrelated to the condition of the surrounding watershed (Debano and Schmidt 1989, Hornbeck and Kockenderfer 2000). The health of riparian corridors is dependent on the storage and movement of sediment and water from surrounding hillslopes into the channel system.

Riparian areas can be defined in two ways. The Malheur Forest Plan defines an administrative buffer width for riparian habitat conservation areas (RHCAs) adjacent to a depositional or erosional channel or meadow feature. The ecological alternative is when a valley supports an elevated water table that provides for wetland plant communities that only occur when conditions are wet for a sufficient duration.

The administrative RHCA boundary typically contains both the water table supported extent and an upland vegetative extent. The Malheur Forest Plan establishes RHCAs into 4 categories: category 1 is fish bearing with a 300 foot buffer; category 2 is a perennial channel with no fish present and a 150 foot buffer; category 3 is a wetland greater than 1 acre and has a 150 foot buffer; category 4 is an intermittent channel or a wetland less than 1 acre and has a 100 foot buffer. These buffer widths apply to both sides of a stream. Therefore, a fish bearing channel would have a 600 foot buffer from one side of the stream to the other. Approximately 15 percent (6,080 acres) of the entire planning area is designated as a RHCA.

Figure 6 illustrates the RHCAs by category in the planning area. Ecological riparian areas are much smaller in total area and are driven by either snowmelt runoff or subsurface, groundwater inputs in the Camp Lick planning area.

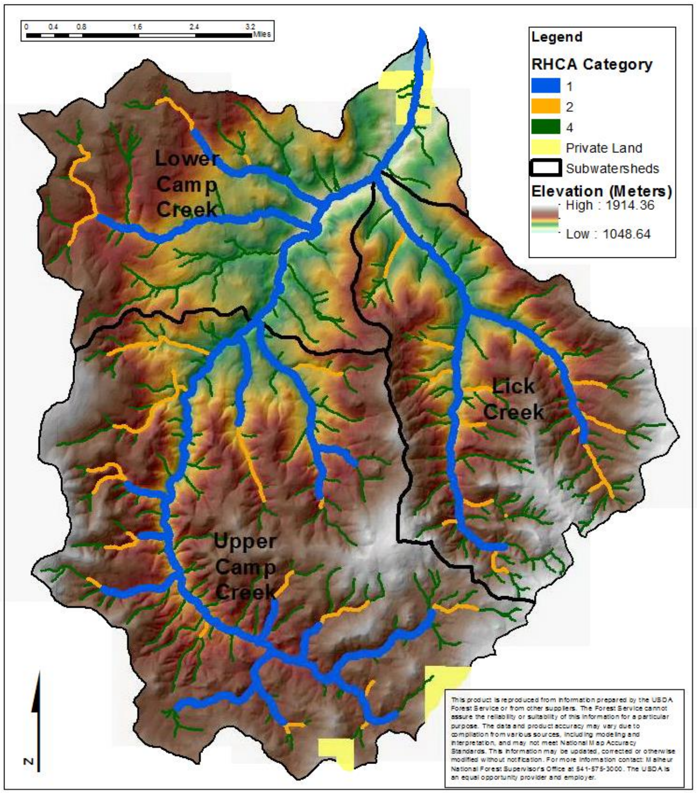

Figure 6. Malheur Forest Plan administrative riparian habitat conservation areas (RHCAs) that route water and sediment inputs through the channel network

In the planning area, riparian conditions shift dramatically across moisture gradients from Engelmann spruce-dominated, to willow/alder communities, to sedge/rush community types. Many riparian areas within the Camp Lick planning area are dominated with conifers as opposed to riparian hardwoods like willow, alder, dogwood, maple, cottonwood, aspen, and others. Within forested riparian stands, time since disturbance (typically fire or flooding) strongly drives the distribution of riparian hardwoods with conifers and successional stages. Whereas, in meadow riparian systems, flooding, beaver, and livestock/wildlife use can impact the successional stage of the plant community. Therefore, meadow and forested riparian areas will be discussed separately.

The Blue Mountains Forest Partners have developed zones of agreements that outline important watershed and reach scale processes and functions for riparian areas. This report tiers to those critical linkages. Additional information on existing conditions are available to the public through streaming the resource story on youtube for Watershed in the Camp Lick planning area (https://www.youtube.com/playlist?list=PL6ZBnsdnJddpdGaiVn2KrPp4Ri55bNC5d).

Riparian

Meadow

Stream channels and meadows with stream gradients less than 3 percent slope are defined as depositional zones. Depositional zones in the planning area occur mostly as higher order streams and have larger drainage areas. These depositional areas, or meadows, in the planning area (see Figure 12) historically stored a very large amount of snowmelt runoff, but their storage reservoirs have been decreased through channel incision. Loss of storage functions affect the ability for watersheds to attenuate flood pulses. During flood pulses, well connected floodplains become inundated and store large amounts of water within the valley. Channel incision lowers the bed elevation, and hence the adjacent water table elevation across the floodplain. Channel incision likely started when roughness elements of beaver dams, riparian vegetation, and/or large woody debris was altered in the past. Also, channel incision occurred when levees or other hard structures (railroad grades in Camp Creek reaches 1-5) inhibited floodplain connectivity.

Channel incision has had a dramatic transition in riparian vegetation because of a decrease in surface water storage and water table changes that affect suitability for wetland obligate plants to get established and maintained. As a result, riparian vegetative species composition shifts away from wetland obligate plant communities (e.g., cottonwood, willow, alder, and sedge) towards upland obligate plant communities (e.g., lodgepole pine and Kentucky bluegrass or red top). Camp Creek reaches 1, 3, 4, 5, 7, 8, 9, 10, and 11 are examples of this in the Camp Lick planning area. Miles of stream within these reaches currently have a lowered water table with lodgepole and ponderosa pine encroaching into portions of the floodplain where it historically was unable to get established due to wetter conditions.

Many of the current riparian conditions are a direct result of past land use management actions. Historically (pre-1975), riparian areas were identified as sacrifice areas for range management. Around the early 1980s, significant livestock management changes occurred from season long grazing to a rest rotation grazing system. As a result, alders started colonizing the streambanks. Those alders are all the same age and have been experiencing insect and disease problems and are starting to die back. Having multiple species of riparian hardwood with multiple age classes is a necessary step for resiliency. Currently, only older age classes of cottonwood are present along the lower reaches of Camp Creek (reaches 1-7). Cottonwood and willow are highly desirable by livestock and wild ungulates and may take longer to get established.

Figure 7. Camp Creek reach 11 illustrating a beaver dam that is not functional and lodgepole pine that is encroaching towards the channel due to drying trends

Figure 8. Gully present within a stream channel on Coxie Meadow and lodgepole pine that has established within the meadow adjacent to the gullies

Figure 9. Camp Creek reach 10 illustrating large streambed substrate

Figure 10. Cross section survey at Camp Creek river mile 12.2 illustrating channel incision and lodgepole pine encroachment

Three headwater wet meadows are currently in a degraded condition along tributaries to Camp Creek. Coxie Meadow occurs at the headwaters of Coxie Creek, Bear Wallow occurs in the headwaters of Cottonwood Creek, and Whiskey Meadow at the headwaters of Whiskey Creek. Gullies exist in all three meadows and are in a “functioning at risk” condition due to channel incision. Water table reductions due to channel incision has reduced the area of wetland obligate plant communities that can occur.

Forested

As discussed in the Silviculture Report, riparian forests occupy approximately 5,460 acres (13 percent) of the planning area. Past timber management and fire suppression activities have influenced the greatest departure in forested riparian stands, particularly to species composition and densities. Past timber harvest activities removed the large trees, and as a result, the understory has doubled or tripled in tree density. Past fire suppression efforts have limited the number of fire patch disturbances in a fire-dependent ecosystem. As a result, late seral species (grand fir and Douglas-fir) are increasing in cover and are the primary species becoming established under the closed canopy conditions that have been increasing. These conditions have led to a closing of the canopy over streams in the planning area.

Forested riparian areas have their canopies close in under the absence of a wildfire disturbance. Canopy closure negatively influences: 1) patches of early seral species (ponderosa pine and western larch) from becoming established, and 2) riparian hardwoods from being diverse and having multiple age classes present. A mosaic of early seral species is very important for future large woody debris recruitment and for providing instream wood that would persist and provide long-term structure to the stream channel. Late seral species like grand fir are known for decaying quickly once the wood has fallen to the ground. Riparian hardwoods are also a very important attribute of forested riparian systems because they provide: 1) high bank stability from fibrous root systems, 2) higher quality shade for the higher leaf area that provides shade directly over the stream, 3) the relative humidity changes and microclimate effects of cooler air temperatures directly over the stream, 4) the leaf fall that occurs and drives nutrient cycling fluctuations and macroinvertebrate communities downstream, and 5) hydraulic roughness and an anchor for coarse or large woody debris jams. Riparian hardwoods are present in many forested riparian areas across the planning area. However, many occur in limited extents and are missing multiple age classes and the species needed for resiliency.

Ecologists use plant association groups (PAGs) as a temperature-moisture matrix framework for aggregating stands. Warm Dry, Cool Moist, and Cold Dry occupy approximately 86 percent of the riparian area PAGs (Table 9) and will be discussed in greater detail for stand density index, crown fire initiation, and structural class. Warm Dry PAG (58.2 percent of total RHCA) tree species include grand fir, ponderosa pine, western larch, and Douglas-fir. Cool Moist PAG (20.7 percent of total RHCA) tree species include grand fir, lodgepole pine, Engelmann spruce, western larch, and ponderosa pine. Cold Dry PAG (8.6 percent of total RHCA) tree species include grand fir, Engelmann spruce, lodgepole pine, and Douglas-fir.

Table 9. Plant association groups (PAG) for riparian habitat conservation areas (RHCA) in acres and percent of total Camp Lick planning area

Plant association group	Acres	Percent in PAG from RHCA total
Warm Dry	3,176	58.2%
Cool Moist	1,131	20.7%
Cold Dry	467	8.6%
Warm Moist	271	5.0%
Cool Dry	216	4.0%
Warm Very Moist	93	1.7%
Hot Dry	76	1.4%

Stand density index (SDI) is a tool that allows land managers with an ecologically appropriate basis for establishing sustainable tree stocking levels, or as an indicator of "carrying capacity." Foresters use SDI to evaluate when stocking levels for each PAG get to a level where density-dependent mortality occurs and the forest self-thins. Each tree has a different tolerance to overcrowding conditions, and shade-tolerant tree species (grand fir and Douglas-fir) have competitive advantages. Warm Dry, Cool Moist, and Cold Dry PAGs were assessed for amount of area above, within, or below management zones (see Table 10). Management zones are important because it can have impacts on tree mortality, amount of water and nutrients available, and quality of large woody debris recruitment.

Table 10. Stand density index (SDI) for the three most common plant association groups (PAGs) in riparian habitat conservation areas in acres and percent of total PAG

Stand density index by plant association group	Acres	Percent in PAG SDI from RHCA total
Warm Dry above the management zone	2,586	82%

Stand density index by plant association group	Acres	Percent in PAG SDI from RHCA total
Warm Dry within the management zone	290	9%
Warm Dry below the management zone	300	9%
Cool Moist above the management zone	943	83%
Cool Moist within the management zone	23	2%
Cool Moist below the management zone	165	15%
Cold Dry above the management zone	393	84%
Cold Dry within the management zone	40	9%
Cold Dry below the management zone	34	7%

Riparian forests provide important shading processes that maintain conditions for cool-water fish. Portions of these forests are at risk for a potential crown fire that could consume the overstory and limit the shade producing canopy. Table 11 illustrates the amount of acres with the various crown fire initiation classes and the percent of total.

Table 11. Crown fire initiation for the three most common plant association groups (PAGs) in riparian habitat conservation areas in acres and percent of total PAG

Crown fire initiation by plant association group	Acres	Percent of total plant association group
Warm Dry: high, very high, and extreme	2,144	67%
Warm Dry: medium	918	29%
Warm Dry: low	113	4%
Cool Moist: high, very high, and extreme	814	72%
Cool Moist: medium	295	26%
Cool Moist: low	22	2%
Cold Dry: high, very high, and extreme	302	65%
Cold Dry: medium	158	34%
Cold Dry: low	7	1%

Perennial stream reaches in the Camp Lick planning area were analyzed using NetMap for the amount of current shade provided by riparian canopy for solar radiation at that reach segment, versus the amount solar radiation that would occur if no riparian canopy was present (see Figure 11). This is illustrated into three categories where riparian forests provide high, medium, and low shade functions for the perennial water system. Stand condition and resilience to wildfire disturbance, particularly crown wildfire processes, are important forest health attributes when discussing riparian shade processes for Endangered Species Act (ESA) listed stream habitat functions. Many of the forested riparian stands identified that provide important shade are also at risk for crown fire.

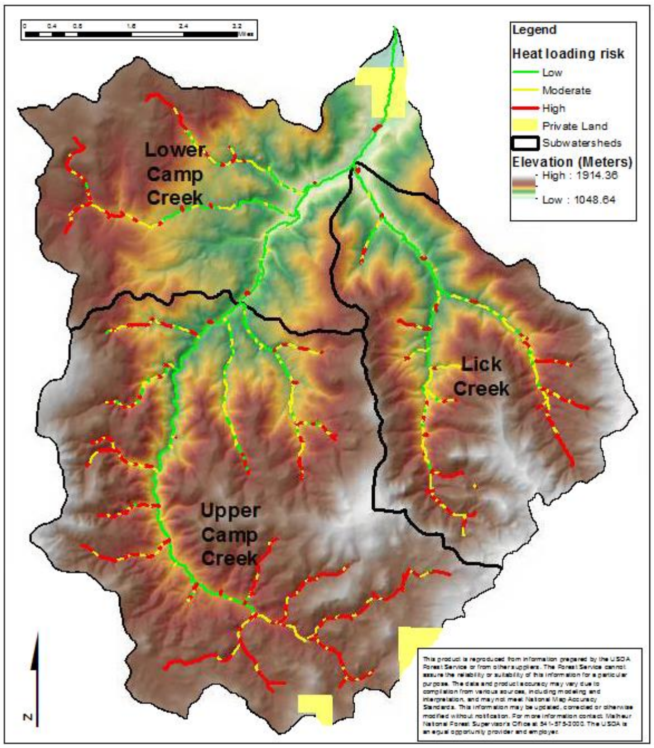

Figure 11. Map illustrating the importance of conifer riparian forests providing shade to perennial streams in the Camp Lick planning area

"Good" functioning riparian/wetland vegetation conditions indicate that native vegetation appropriate to the site's potential dominates the plant communities and is diverse in age, structure, cover, and composition on more than 80 percent of the true riparian areas. Young, mid and old age classes of native species appropriate to the site is occurring to ensure sustainability. The three subwatersheds within the planning area are rated as "fair, functioning-at-risk" condition. Areas displaying light to moderate impact to structure, reproduction, composition, and cover may occupy 25 to 80 percent of the overall riparian area. The riparian areas illustrate moderate impact closer to 70 percent of the overall riparian area.

In general, meadow and forested riparian conditions appear to be functioning at the low end of the "fair" rating for the Blue Mountains. Most riparian conditions are generally recovering into the natural range of variability from past management activities. However, riparian hardwoods are disappearing in their species diversity and age class distribution due to closing canopy conditions that are fully stocked. This is negatively affecting leaf fall inputs and nutrient cycling processes into the streams from headwater tributaries. The forested riparian areas are also above management zones for stocking levels and are at risk to insects, disease, and crown fire. Unconfined and moderately confined valleys are stocked with more fuels with greater connectivity at larger scales in riparian areas in the planning area. Their ability to provide large wood recruitment of early seral species that is of adequate size to influence channel forming processes is at risk.

Stream Channel Shape and Function

Watersheds that have functioning physical processes form high quality stream channels and provide high quality aquatic habitat. Watersheds in "good" condition tend to retain most of their natural complexity such as preserving the lateral, longitudinal, and vertical connections between system components, as well as the natural spatial and temporal variability of these components (Naiman et al. 1992). Floodplain connectivity demonstrates maintenance of the vertical component of stream channels and provides for off-channel habitat, among other features. Habitat fragmentation evaluates the longitudinal component of healthy systems. Aquatic habitat fragmentation by fish passage blockages, dewatering, or temperature increases, along with simplification from activities including channelization, channel bed sedimentation, woody debris removal, and flow regulation, results in loss of diversity within and among native fish species (Lee et al. 1997). Maintaining heterogeneous and complex aquatic organism habitat at multiple scales is recognized as an important influence on species diversity and ecosystem stability (Sedell et al. 1990).

Channel form (width-to-depth ratio), vertical stability (indicator for channel incision), and floodplain connectivity are three indicators for determining if conditions are functioning, or if they exhibit impacts from human influence. These three indicators are integrated to define channel shape and function. Channels achieve a dynamic equilibrium over time where the sediment and water inputs are in balance with the stream slope and sinuosity (degree of meandering) of the channel.

In the Camp Lick planning area, past land uses have altered the system's ability to dissipate energy. As a result, the stream channels have become vertically unstable, meaning they have incised into their floodplain and are not connected to their floodplain under normal flood events. As a result, they lose their ability to provide good habitat or ecosystem functions like groundwater recharge, water table maintenance, riparian biomass, and nutrient cycling.

Stream channels across landscapes are conveyance systems (or process zones) for sediment and water. Geomorphologists define three general categories for understanding stream behavior and water/sediment process fluctuations over time. Source zones (stream slopes greater than 20 percent) are areas where runoff and sediment from hillslope erosion processes originate. Transfer zones (stream slopes from 3 percent to 20 percent) are conveyor belts for processing materials through the channel network. Depositional zones (stream slopes less than 3 percent gradient) allow sediment and water to accumulate in larger concentrations. In the Camp Lick planning area, water and sediment spend a longer duration and accumulate in larger magnitudes in the depositional zones annually during the water cycle. Channel shape and function is analyzed within the depositional environments because they tend to provide the highest amounts of habitat within the stream network. Depositional zones occur in the planning area on almost all of Camp Creek (reaches 1-11), Lick Creek reach 1, Cottonwood Creek reach 3, and in the three headwater wet meadows (see Figure 12).

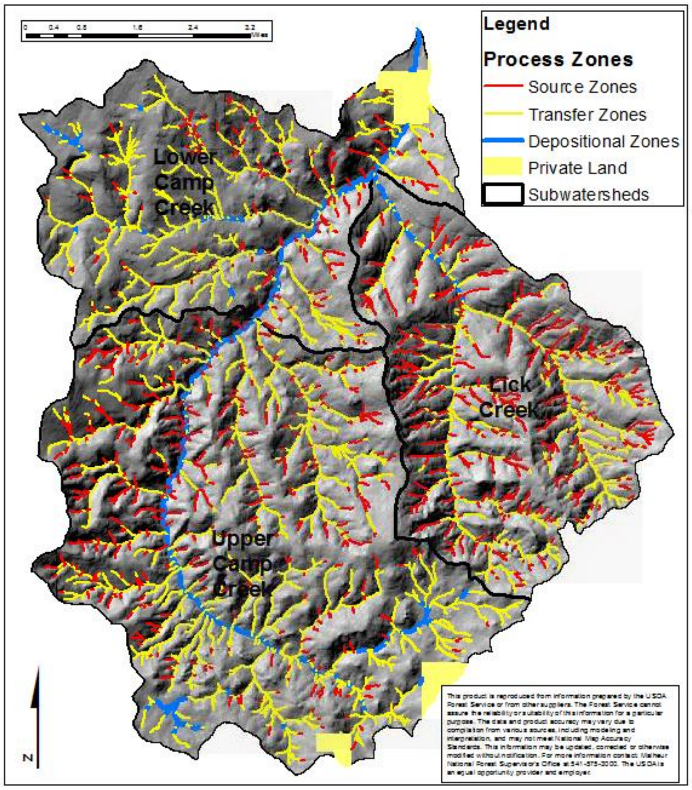

Figure 12. Map illustrating erosional and hydrologic process zones (defined by stream slope) that are most frequently found within the Camp Lick planning area

Camp Creek generally functions as an alluvial pool/riffle system and constitutes most of the depositional areas in the Camp Lick planning area. An alluvial pool/riffle system is formed in a low gradient stream with a lateral bedform and established floodplain. The majority of stream reaches are classified as C channel types, with exceptions being some B and E types as well. The lower reaches are laterally constrained by old levees, a railroad grade, and roads which have the effect of separating the channel from its historical floodplain. The levee is functioning like a hillslope, and as a result, the channel lacks complexity and is dominated by riffle features. Evidence of old side channels and past floodplain connectivity are abundant within the valley bottom, but it has been many years since the channel has freely accessed the historical floodplain. The upper reaches were not impacted as much by the legacy structures, but experienced channel incision through loss of beaver dams. Overall pool numbers are low and quality pools are lacking throughout the streams within the planning area.

The channel shape and function indicator was assessed through evaluating depositional zones in the planning area and evaluating the degree of overwidening, vertical instability, and floodplain confinement issues. Channel type tables in the Watershed Report Appendix A illustrate the existing and desired channel shapes and professional judgement was used to evaluate vertical stability and floodplain connectivity issues. If less than 5 percent of the stream channels show signs of these issues, then the subwatershed would rate as "good, functioning properly." If 5 to 25 percent of the depositional zones show these signs, then it would be rate as "fair, functioning at risk," and at greater than 25 percent it would rate as "poor, impaired function." The Lick Creek subwatershed is rated as "fair, functioning at risk," in large part because it is dominated with Rosgen B channel types (transport reaches) and is within its range of variability. However, riparian shrubs are sparse, as are large woody debris pieces that would help improve floodplain connectivity and channel narrowing/deepening processes. The Upper Camp Creek subwatershed was rated as "poor, impaired condition" due to the channel incision that has downcut the streambed. As a result, the channel lacks frequent flooding on current terraces (historical floodplains) that would improve its channel form and ability to provide high quality habitat. The Lower Camp Creek subwatershed was rated as "poor, impaired condition" due to the constraints of the levee features (historical railroad grades) that impact that channel's ability to migrate laterally, and the floodplain's ability to be inundated regularly. Both the Upper Camp Creek and Lower Camp Creek subwatersheds have been negatively impacted by historical and current beaver trapping, historical livestock grazing, and the loss of riparian vegetation. Riparian vegetation provides the root reinforcement that maintains high quality stream channels.

Headwater stream channels in Camp Creek, Coxie Creek, and many other tributary headwaters in the veruccated landform associations are eroding and cutting headward, or upstream. These gullies are being created due to the lack of coarse wood in the stream channel causing roughness, connecting floodplains, and providing elevated water tables for wetland plant communities to form in patches. Over the last 20 years, the stream channel conditions are gradually recovering due to changed land management techniques, previous restoration efforts, and an improved understanding of the importance of riparian management.

Figure 13. Eroding Camp Creek headwater tributary

Figure 14. Sulphur Creek showing low instream wood volumes (large wood jam features once stored sediment and water later into the summer)

Source zones (colluvial draw stream channels greater than 20 percent slope) occupy nearly 102 miles of stream or 32 percent of the total stream network in the planning (see colluvial channels in Figure 15).

Upland forests would accumulate fuels over time and a high severity wildfire would likely occur in an area that is a source zone. Many of these portions of the stream channel historically delivered substantial amounts of wood and sediment to depositional reaches (Reeves et al. 2003). Wondzell et al. (2007) modeled debris flow reoccurrence at 333 years for the Blue Mountains landscape. They state that it is a conservative interval longer than that of stand-replacing wildfire. The article states "that debris flows usually occur where intense storms affect areas recently burned by stand-replacing wildfires. . . . Stand replacing wildfires occur once every 90-300 years in the cool-moist conifer forests" (Wondzell et al. 2007). Past wildfire suppression has altered stand-replacing wildfire occurrence over the past 150 years. As a result, the stream network has not received episodic pulses of sediment. Camp Creek is incised and could use the sediment to restore floodplain connections and improve its channel form. However, the dissected portion of the Lick Creek subwatershed does produce landslides that do not require wildfire to provide episodic pulses of sediment to that stream network. As a result, gravel is more frequent and so is steelhead spawning in Lick Creek.

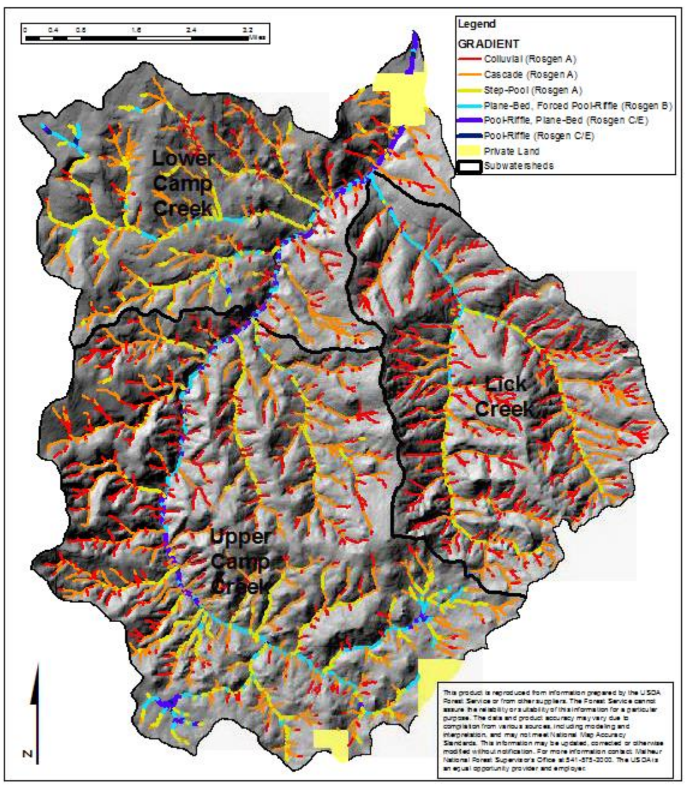

Figure 15. Montgomery/Buffington and Rosgen stream type map illustrating channel types (defined by stream slope) that are most often found within the Camp Lick planning area

Large Woody Debris

Large woody debris in streams is an important roughness element influencing channel morphology, sediment distribution, and water routing (Swanson and Lienkaemper 1978). Large wood influences channel gradient by creating step pools and dissipating energy (Heede 1985), lengthens streams by increasing sinuosity, and serves as an important agent in pool formation (Montgomery et al. 1995). In low order streams, in particular, large wood collects sediment and larger substrates during high flow events (Keller et al. 1979) and can account for 50 percent of the sediment/substrate storage sites (Megahan 1982). Further, large wood is instrumental in nutrient retention by capturing and storing salmon carcasses (Cederholm and Peterson 1985) and allochthonous materials, a primary energy source for smaller rivers and streams (Lamberti et al. 1991). Large wood pieces/mile is also defined as Forest Plan standard and is present in Appendix A of the Watershed Specialist Report.

Large wood is an important component within the stream network for meeting many ecosystem functions. These systems evolved with wood near the streams and requires disturbance processes to self-maintain large wood recruitment processes at near natural rates. Ecosystem processes and functions caused by wood in streams include increased sediment retention, hyporheic flow, structure for floodplain connectivity and floodwater storage, organic matter processing, primary and secondary productivity, and nutrient cycling.

Large wood in almost all the streams were reported to be below Forest Plan standards, according to recent USFS Region 6 stream surveys conducted in the planning area (see Watershed Report Appendix A). Camp Creek reach 6 and Sulphur Creek reach 1 were the only streams meeting large woody debris riparian management objectives. Field observations found woody materials to be recovering to lower ranges of natural variability in Camp Creek reaches 8 and 9 due to recent restoration efforts in the summer of 2016. Large and coarse woody debris were removed from many streams in the past to prevent flooding, and as part of meeting timber contract specifications. Trees that were within the large woody debris recruitment zone in some reaches have been commercially harvested in the past and have directly impacted current instream wood loads. The lack of any large wildfire in the past 100 years due to fire suppression has also impacted instream large wood debris loads from being recruited.

As a result, all three subwatersheds were rated as “poor, impaired condition” for large woody debris. The forested stream network should contain large wood as an ecosystem component. Wood is lacking, resulting in “poor” riparian or aquatic habitat conditions, including inadequate pool formation.

Water Quality

Water quality in the planning area is currently at risk, due in large part to the condition of the other watershed condition class indicators. Beaver historically maintained high quality riparian habitat before being trapped out of the planning area. Historical livestock grazing, timber harvesting, and the constraint of floodplain processes due to railroad grades all contributed towards channel instability through incision or downcutting into the streambed. Channel incision and loss of the water table has had domino effects to the riparian vegetation’s role in: 1) regulating solar radiation and providing shade, 2) providing root reinforcement and maintaining a proper channel form (width to depth ratio), 3) nutrient cycling from leaf fall of riparian hardwoods, 4) providing flow resistance to peak flow events, and 5) providing habitat for beaver, fish, and wildlife. Headwater tributary streams have canopies closing in and shade provided by conifers, but not many riparian hardwoods present. These ecosystem functions are interconnected and interrelated, the degradation of one function creates a domino effect to the others, causing increasing impacts to water quality.

Impaired waters Oregon (303(d) listed) – Biocriteria

The water quality condition was assessed through comparing the miles of stream within each subwatershed that are currently Oregon 303(d) and/or water quality limited. No streams within the Camp Lick planning area are currently on the Oregon 303(d) list. Approximately 15.6 miles of Camp Creek is listed as a Category 3B status, meaning potential concern. The pollutant parameter is biocriteria and is applicable year around. The criteria is that "waters of the state must be of sufficient quality to support aquatic species without detrimental changes in the resident biological communities" (ODEQ 2016).

Biocriteria, or aquatic insect diversity, is an important component in functioning watersheds. Riparian hardwoods have leaves that fall into the stream each fall. Shredder functional groups (caddisfly, cranefly, and mayfly larvae) help break down the leaves into smaller detritus and convert organic matter that is then used by collector/gatherers (stonefly, mayfly, and caddisfly larvae) or filter-feeders (copepod, midge larvae, amphipod, freshwater hydra, and freshwater mussels). Predator functional groups (water beetle, dragonfly larvae, water strider, dobsonfly, and water boatman) feed on these functional groups. Juvenile fish depend on the drift component of aquatic insects to grow and expend energy. Biocriteria has been negatively altered by Camp Lick's degraded headwater wet meadows, limited floodplain connectivity with incised channels in most depositional reaches, lowered water tables, decreased riparian biomass, limited beaver population with active trapping permitted, and conifers closing the canopy on riparian hardwoods in most tributary streams. However, streams within the project area are not 303(d) listed for biocriteria at this time.

Water Quality Problems -- Temperature

Camp Creek was "303(d)" listed, meaning it was water quality limited in the 1998 Oregon DEQ database. It was the only stream within the Camp Lick planning area with a "303(d)" status. The State of Oregon's Department of Environmental Quality (ODEQ) set thresholds for total maximum daily loads (TMDLs) for waterbodies in the John Day Basin (ODEQ 2010). With the issuance of the John Day Basin TMDL for water temperature and the subsequent completion of the John Day TMDL Water Quality Restoration Plan by the Malheur National Forest and others, all streams have been delisted since the 2010 Oregon DEQ database.

Effective shade is a Forest Plan standard and is an important riparian process that maintains lower water temperatures for high quality aquatic habitat. Shade was measured with a solar pathfinder to assess the condition for various reaches within the planning area (Figure 16). The existing effective shade values are compared to Forest Plan standards in Watershed Report Appendix A. Shade measurements did not meet Forest Plan standards for Camp Creek reaches 1-9, however, reaches 10 and 11 did met their standards as the valley narrows where the trees and topography provided higher shade. The lower reaches of Camp Creek have very wide valleys where hillslope trees or the topography do not provide much shade relief. Also, alder beetles have defoliated the leaves along portions of Camp Creek.

East Fork Camp Creek is very close to meeting Forest Plan standards. Lick Creek and Coxie Creek do not meet shade standards. West Fork Lick Creek, Cottonwood Creek, Big Rock Creek, Charlie Creek, Cougar Creek, Eagle Creek, Little Trail Creek, Shoberg Creek, and Trail Creek do meet standards. Whiskey Creek met in reach 2, but not reach 1. Shade is currently being provided by conifers. Historically, riparian hardwoods provided much more shade through these mainstems and their tributaries.

Figure 16. Solar pathfinder measuring the amount of effective shade provided by adjacent vegetation and hillslopes

TMDL standards are for the 7-day average of daily maximum temperatures (7DADM). The Camp Lick planning area has one standard that is applicable, core cold water habitat. The core cold water habitat of 16.0 degrees Celsius (60.8 degrees Fahrenheit) 7DADM applies to the Camp Creek, Lick Creek, and the perennial tributaries that drain to these creeks. The Malheur Forest Plan, PACFISH, and Forest Plan Amendment 29 all have varying water temperature standards. The TMDL is the state water quality standard and is the most conservative value. Therefore, for this analysis the TMDL standards will be used.

Water temperatures exceeded their standards for all sites sampled, except for Cougar Creek, Lick Creek, and Sulphur Creek in their headwaters. The 7DADM temperatures for various sites in the planning area are listed in Table 12 below, Figure 7 shows the locations of the temperature sampling sites. Camp Creek had multiple temperature probes deployed throughout its length. Water temperatures draining from forested headwater tributaries in the Upper Camp Creek subwatershed are flowing around 66 degrees Fahrenheit (66.8 degrees Fahrenheit at Coxie Creek, 66 degrees Fahrenheit at Camp Creek headwaters, and 66.5 degrees Fahrenheit at East Fork Camp Creek). The largest increase in water temperature occurs between sites 6 and 7 (approximately 8.6 degrees Fahrenheit) on (meadow riparian) reach 8 over 2.3 miles. This increase in water temperature through Camp Creek reach 8 impacts steelhead survivability for juvenile rearing. It was recognized that this reach was non-functioning due to a lowered water table, impaired channel width-to-depth ratios, lack of shade (existing 36 percent, versus the desired 80 percent), and lodgepole encroachment. Restoration activities implemented in 2016 included constructing beaver dam analogues and adding more than 10,000 plants to encourage a restored water table, riparian shade, connected floodplains, and water storage functions. This project may take 5 to 10 years to observe restored shade functions from the planted hardwoods.

Table 12. The 7 day average daily maximum water temperatures and standard values for select sites within the planning area

Site name	7 day average daily maximum temperature (degrees Fahrenheit)
Camp 1	78.2
Camp 2	75.2
Camp 3	70.8
Camp 4	71.9
Camp 5	76.2
Camp 6	77.1
Camp 7	68.5

Site name	7 day average daily maximum temperature (degrees Fahrenheit)
Camp 8	66
Cottonwood 1	62.4
Cougar 2	58.9
Coxie 1	66.8
Coxie 2	63.4
East Fork Camp 1	66.5
Lick 1	71.9
Lick 2	62.8
Lick 3	55
Sulphur 1	69.4
Sulphur 2	55.3
Trail 1	64.9
West Fork Lick 1	71.1

The Malheur National Forest now follows the TMDL implementation strategies, which outline how stream shade is provided from riparian vegetation, channel form, and aspect. Also, how water flows through the streambed if a large woody debris jam is present, allowing hyporheic flow to incrementally cool water temperatures.

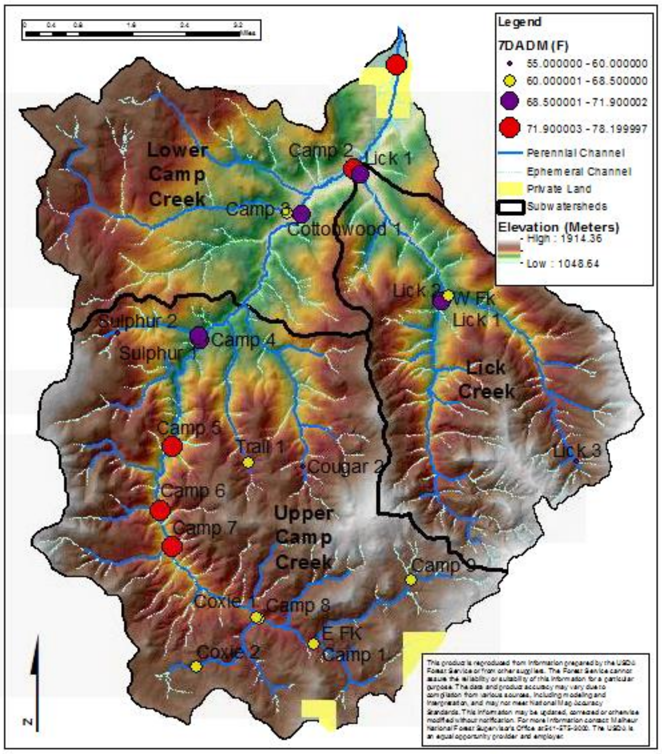

Figure 17. The 7 day average daily maximum (7DADM) water temperature at several sites for water year 2014

Desired Condition

Desired conditions for riparian function within the Camp Lick planning area include conditions where biophysical processes are in balance with the active disturbance processes, and that ecosystem functions produce many benefits to water quality, wildlife and fisheries, the communities served, and maintain riparian forests over the long-term. The Upper Camp Creek, Lower Camp Creek, and Lick Creek subwatersheds would provide favorable water flows of clean water and provide many benefits to local communities.

Meadow riparian systems would have connected floodplains that assist in providing water storage and riparian vegetation, which provide high quality shade. Multithreaded channels would occur between beaver dams in the majority of depositional reaches with unconfined valleys. Multiple age classes of cottonwood, willow, alder, dogwood, and aspen would occur across the broad floodplains. Abundant riparian biomass would accumulate and create high quality habitat for fish and wildlife. Floods would carve new gravelbars and create desirable fluvial disturbances.

Forested riparian systems would have forest communities in all seral stages with various patch sizes of younger cohorts. They would exist in different fuel accumulations and crown fire potentials in the mosaic of a mixed severity fire regime. Early seral species (western larch and ponderosa pine) would have 2 to 3 times more species composition by volume in unconfined and moderately confined valley areas. Confined valleys would have denser accumulations of late seral vegetation species and would have more of a high fire regime. Overall, frequent fire disturbances would have Warm Dry plant association groups in more of an Old Forest Single Stratum (OFSS) structural state. Cool Moist plant association groups affected by windthrow, disease, and wildfire disturbance processes would have more Old Forest Multiple Stratum (OFMS) or Young Forest Multiple Stratum (YFMS) structural states.

Figure 18. Windthrow and flood disturbances resulting in a canopy opening with early seral tree species, abundant down wood, and riparian hardwoods present

Large and coarse wood would be abundant and would be input by the following disturbances (windthow, disease, wildfire, flooding, bank erosion, and debris flows). Early seral wood would persist inchannel and across the valley, building steps in the valley longitudinal profile or forming pool habitats. Loading of instream wood would be in balance with the adjacent riparian forest's age class. Generally, older forests would provide higher loads of instream wood than younger forests. Large wood would provide hydraulic roughness, capturing sediment and building steps or riffles, increasing hyporheic flow through the streambed. It would capture detritus and leaf fall, which would be broken down in debris jams by aquatic macroinvertebrates. Large wood would connect floodplains with channels and increase water attenuation and storage, but also increase the formation and maintenance of patches of wetland obligate plant communities with an elevated water table.

The Camp Lick planning area would have functioning physical processes which would help form high quality stream channels and provide high quality aquatic habitat. Watersheds in good condition tend to retain most of their natural complexity such as preserving the lateral, longitudinal, and vertical connections between system components as well as the natural spatial and temporal variability of these components (Naiman et al. 1992). Streams would be well connected to their floodplains and provide off-channel habitat and wetlands. Sediment and wood would be input across the watershed over time in response to disturbances, and would be captured into the stream channel. Camp Creek's depositional reaches would be aggrading and filtering through intact beaver dam colonies. However, segments of reaches would also be overharvested by beaver and failing beaver dams in these areas could also provide sources of desirable sediment.

The desired functioning condition for the Camp Lick planning area is to have a properly functioning watershed at the 5th field scale, including restored natural processes and disturbance mechanisms that allow the watershed to maintain diversity and complexity. The desired future condition for watershed resources in the three 6th field subwatersheds within the Camp Lick planning area can be best described as having a range of variability for riparian, stream channel, and large woody debris conditions. Historically, flood, drought, fire, wind, snow, ice, and land movement all played a natural role in determining the diversity of conditions. Historical wildfire patterns created a mosaic of structural classes. Some hotter wildfires in the headwater areas led to episodic pulses of sediment that were filtered through Camp Creek's depositional valley. Beaver dams aggraded the sediment, where sedge, willow, and cottonwood communities thrived. High quality steelhead habitat is provided by connected floodplains, high riparian biomass offering abundant shade, and high groundwater recharge. Past management activities within the Camp Lick planning area have produced results falling on the low end of the natural range of variability for watershed conditions. This is primarily due to past beaver trapping, timber harvest, fire suppression, and livestock disturbances.

Figure 19. A 4-foot persistent beaver dam anchored off a large woody debris jam in Camp Creek reach 4 illustrating the benefits of floodplain connectivity, groundwater recharge, and water attenuation

The desired future conditions for riparian, stream channel, large woody debris, and water quality conditions within the planning area meet objectives coming from multiple sources including: Malheur Forest Plan and John Day Total Maximum Daily Load. Goals from PACFISH to maintain or restore watershed resources, include:

- Water quality that provides for stable and productive riparian and aquatic ecosystems.
- Stream channel integrity, channel processes, and the sediment regime (including the elements of timing, volume, and character of sediment input and transport) under which the riparian and aquatic ecosystem developed.
- Instream flows to support healthy riparian and aquatic habitats, the stability and effective function of stream channels.
- Natural timing and variability of the water table elevation in meadows and wetlands.
- Diversity and productivity of native plant communities in riparian zones.
- Riparian vegetation to:
    - Provide an amount and distribution of large woody debris characteristic of natural aquatic and riparian ecosystems.
    - Provide adequate summer and winter thermal regulation within the riparian and aquatic zones.
    - Help achieve rates of surface erosion, bank erosion, and channel migration characteristic of those under which the communities developed.

- Habitat to support populations of well-distributed native plant, vertebrate, and invertebrate populations that contribute to the viability of riparian-dependent communities.
- Manage towards attainable and site-specific riparian management objectives (RMOs). RMOs provide the ‘criteria’ against which progress towards attainment of the riparian goals can be measured. The goal of RMOs are to achieve a high level of habitat diversity and complexity. Pool frequency is the key feature, followed by the secondary features of water temperatures, large woody debris, bank stability, lower bank angle, and width/depth ratio.
- The desired conditions for the indicators of various key reaches can be found in the Watershed Report Appendix A.
- Meet good conditions, or be placed on a trajectory toward meeting good conditions for watershed condition class indicators assessed in this document.

Goals from DEQ’s Total Maximum Daily Load (TMDL) include:

- Restoration of riparian vegetation and channel morphology, including floodplain area and connectivity, targeting natural conditions.
- Instream flow restoration, where flow has been artificially reduced.

Environmental Consequences

Methodology

The district hydrologist used multiple methods to determine the existing condition and to analyze the potential effects to the subwatersheds from proposed activities. By using professional knowledge of the planning area, data collected from Level 2 Hankin and Reeves stream surveys, riparian forested stand exams, water temperature surveys, and meadow surveys, and by reviewing other data and literature, the hydrologist analyzed the effects of the proposed alternatives. Alternatives were compared in terms of effects from proposed actions to riparian function indicators of riparian, stream channel shape, large woody debris, and water quality conditions. NetMap was used to assess shading functions from riparian canopies and for assessing where shade was most at risk if the crown was consumed by a wildfire. NetMap was also used to identify where hillslopes and ephemeral draws are inherently most active erosionally, including the portion of the stream network that is prone to gullying or debris flows. Riparian stand conditions were assessed through use of the Forest Vegetative Simulator. Desired conditions were acquired from Malheur Forest Plan standards and the total maximum daily load (TMDL) assessment for the John Day Basin.

Incomplete and Unavailable Information

Field reconnaissance of streams, meadows, and seeps/springs included the majority of the category 1, 2, and 4 RHCAs in the planning area, but some drainages were not surveyed due to time, resource, and access constraints. Riparian forested stand exams were not conducted on all reaches proposed for riparian treatments, however, they were inventoried to capture a representation of the various plant association groups and stand conditions that occur in the planning area.

Spatial and Temporal Context for Effects Analysis

The analysis used a spatial extent at the 6th field HUC subwatershed scale. Lick Creek, Lower Camp Creek, and Upper Camp Creek subwatersheds were analyzed for direct and indirect effects. Short-term effects are defined as ranging from 1 to 4 years, unless specifically stated. Long-term effects can last from 4 to 100s of years, depending on the processes that are impaired or at risk.

Past, Present, and Foreseeable Activities Relevant to Cumulative Effects Analysis

Past, present, and reasonably foreseeable future activities that were considered for the Watershed Report include: timber harvesting and sales; plantation maintenance; insect and disease outbreaks; past wildfire and fire suppression; riparian enhancement and channel restoration; dispersed camping; hiker, horse, and foot trail; cross country OHV use; past and present livestock grazing; transportation activities; and firewood cutting. The geographical scale analyzed for cumulative effects extends down to the junction of Camp Creek and the Middle Fork John Day River.

Project Design Criteria and Mitigation Measures

Table 13. Project design criteria for Riparian Function

Commented [SHK-1]: Double check table with update from Rosie

Criteria number	Objective	Design Criteria	Areas, units, or activity type	Responsible person
Aquatic and watershed -1	Protect aquatic resources, and follow all applicable laws, regulations, and standards	See Attachment 1 for A. General Water Drafting Guidance for Road Maintenance and Non-emergency Fire Use for Watersheds with Anadromous Fish in the Blue Mountain Tri-Forest Area. B National Marine Fisheries Service Juvenile Fish Screen Criteria for Pump Intakes C. Relevant Project Implementation Criteria for Road Maintenance Activities D. Log Haul Project Design Criteria E includes aquatic and riparian restoration programmatic consultation – Project Design Criteria for Aquatic Restoration Activities F. Key Best Management Practices.	All project activities	
Aquatic and Watershed -2	Minimize water quality threats.	Follow the General Water Quality Best Management Practices, Pacific Northwest Region, November 1988 (USDA Forest Service 1988) and the National Best Management Practices for Water Quality Management on National Forest System Lands, Vol. 1: National Core BMP Technical Guide (USDA Forest Service 2012). Specific BMPs for aquatics specialists applicable to this project include: T1-T22, R1-R15, R17-R23, F2-F3, VM1-VM4, RM1, and W5. Apply all applicable BMPs listed in USDA Forest Service (1988). Full descriptions of each BMP may be found in the Camp Lick EA, Appendix C – Project Design Criteria.	All project activities	Contracting & sale administrator, aquatics specialists
Aquatic and Watershed -3	Minimize equipment disturbance of duff and soil	Ephemeral stream channels should have protections to minimize equipment disturbance of duff and soil, and should not be used as skid trails, landing sites, or as road locations. Ephemeral draws (not within RHCAs) are to meet the following down wood requirements to reduce risk of upward migration and channel initiation: retain all wood embedded in the soil; retain sufficient wood for the forest type in the draw bottom for existing and future down wood. Ephemeral draws with a gradient of 5% or more will need to be visited by the hydrologist to determine if any additional site specific mitigation is required. No timber harvest within ephemeral draw buffer (10 to 50 feet on each side).	All project activities	Contracting & sale administrator
Aquatic and Watershed -4	Meet PACFISH standards	Riparian habitat conservation area (RHCA) buffer widths for category 1, 2, and 4 streams (300, 150, and 100 feet on each side of the stream,	All project activities	Contracting & layout

Criteria number	Objective	Design Criteria	Areas, units, or activity type	Responsible person
		respectively) and for category 3 wetlands (150 feet) shall be consistent with PACFISH.		
Aquatic and Watershed -5	Protect from hazardous materials	The Forest Service will require a Hazardous Substances Plan and Prevention of Oil Spill Plan from contractor which will be reviewed and approved prior to implementation activities. Fuels and other toxicants shall not be stored within RHCAs, and other provisions of PACFISH standard RA-4 shall be implemented.	All project activities	Contracting & sale administrator
Aquatic and Watershed -6	Protect from hazardous materials	Inspect all heavy equipment and machinery for hydraulic or other leaks before working near RHCAs. Leaking or faulty equipment will not be used. Equipment with accumulations of oil, grease, or other toxic materials will be cleaned in pre-approved sites outside RHCAs.	All project activities	Contracting & sale administrator
Aquatic and Watershed -7	Protect aquatic resources	Industrial camping permits will be required. Locations within RHCAs will be coordinated with a Malheur National Forest aquatics specialist before permits are issued.	All project activities	Contracting & sale administrator
Aquatic and Watershed -8	Meet PACFISH standards	Because streams in the aquatics analysis area are deficient in LWD in accordance with PACFISH Standard RA-2, all trees felled within or into RHCAs (including danger trees, those felled for road construction/maintenance, aspen restoration, and aquatic restoration) will either be felled into streams where feasible to provide LWD, or left within the RHCA. Felled trees may be transported off-site for use in aquatic restoration projects as determined by a Malheur National Forest aquatics specialist. Trees felled shall be pushed over with rootwad intact where feasible, rather than cutting (unless felled as part of riparian thinning treatments). This does not apply to riparian enhancement treatments, LWD could be removed in commercial units after riparian management objectives and desired conditions have been met.	All project activities	Contracting & sale administrator
Aquatic and Watershed -9	Protect RHCA resources	During implementation of upland silviculture treatments do not use heavy equipment in RHCAs and do not use off road vehicles within 100 feet of streams, springs, or wetlands.	Upland silviculture activities	Contracting & sale administrator
Aquatic and Watershed -10	Meet PACFISH standards	Follow PACFISH standards and guidelines. Timber management, roads management, and fire/fuels management standards and guides apply to this project.	All activities in RHCAs	Contracting & sale administrator
Aquatic and Watershed -11	Meet PACFISH standards	No yarding of logs will occur within existing meadow areas, only around the edge.		
Aquatic and Watershed -12	Protect aquatic resources	The work period for instream work, including culvert installations on fish-bearing streams, will be July 15 through August 15, as specified in the Oregon Guidelines for Timing of In-Water Work to Protect Fish and Wildlife Resources, June 2008.	Culvert installation, road decommissioning	Engineer, or contracting
Aquatic and Watershed -13	Prevent erosion and runoff	Conduct activities during dry-field conditions – low to moderate soil moisture levels.	Culvert installation, road decommissioning	Engineer, or contracting & sale administrator

Criteria number	Objective	Design Criteria	Areas, units, or activity type	Responsible person
Aquatic and Watershed -14	Meet all applicable standards	Culvert installation and road decommissioning would will be completed in accordance with the Regional General Permit issued by the U.S. Army Corps of Engineers. Minimization measures for fisheries, watershed function, water quality, and soil conditions include those identified in the NMFS and FWS 2013 ARBO II as well as PDCs developed by the Blue Mountain Ranger District interdisciplinary team. A complete listing of ARBO II PDCs specific to this project element is included in Attachment 1 in Camp Lick EA, Appendix C – Project Design Criteria.	Culvert installation, road decommissioning	Engineer, or contracting & sale administrator
Aquatic and Watershed -15	Meet PACFISH standards	All quality pools (pools greater than 2 feet in depth or pools greater than 1.5 feet in depth with cover) will be noted and designed for retention within the planning area.	Culvert installation	Engineer, or contracting
Aquatic and Watershed -16	Meet water quality standards	There should be no measureable loss in streamside shade within the project area from culvert replacement/installation on fishbearing streams. If a measurable reduction in stream shade cannot be avoided, the project will be designed to obtain recovery of streamside shade within an approximate five year period, including the use of riparian plantings.	Culvert installation	Engineer, or contracting
Aquatic and Watershed -17	Prevent erosion	In RHCAs or ephemeral draws, conduct culvert installation, replacement or removal during dry conditions or with approval from the district hydrologist and fish biologist. Prevent erosion of soil into streams during installation using appropriate BMPs (Appendix C – Project Design Criteria). Cease work if a storm event increases stream flows.	Culvert installation	Engineer, or contracting, district hydrologist and fish biologist
Aquatic and Watershed -18	Protect watershed resources	Grapple/hand piling areas will not be located within RHCAs, except for aquatic restoration projects designed for RHCAs.	Prescribed burning	Burn boss, COR
Aquatic and Watershed -19	Restore forest resiliency	Ignition of underburning may occur in RHCAs, and may occur up to 25 feet from the edge of the stream channel (to prevent drip torch fuel from entering the stream). Fire will be allowed to back into the riparian areas.	Prescribed burning	Burn boss
Aquatic and Watershed -20	Protect watershed resources	Firelines will not be constructed within RHCAs and will be waterbarred on slopes greater than 35%. Firelines will utilize existing constructed and natural barriers such as existing roads and streams, and will be rehabilitated to a natural state after use. Fireline construction will not occur down draw bottoms. Hand lines may be used to keep fire out of sensitive areas and private property.	Prescribed burning	Burn boss
Aquatic and Watershed -21	Maintain water quality	There should be no measureable loss in streamside shade within the project area from fence construction on fishbearing streams. If a measurable reduction in stream shade cannot be avoided, the project will be designed to obtain recovery of streamside shade within an approximate five year period, including the use of riparian plantings.	Range activities	Rangeland manager

Criteria number	Objective	Design Criteria	Areas, units, or activity type	Responsible person
Aquatic and Watershed -22	Protect riparian hardwoods	Minimize disturbances to riparian hardwoods greater than 2 feet in height located within the floodplain or providing bank stabilization. Consider cutting hardwoods at their base where equipment crossings are needed. This will encourage re-sprouting at a faster rate.	Riparian restoration activities	Contracting & sale administrator
Aquatic and Watershed -23	Protect watershed resources	Obtain approval from district fisheries biologist and hydrologist on specific methods for removing culverts from streams.	Road decommissioning	Engineer, or contracting & sale administrator
Aquatic and Watershed -24	Erosion control	Decommission roads by some combination of the following: recontouring slopes (removing cut and fill slopes); subsoiling (loosening) compacted soils in a “J” pattern to a depth of 16 inches (unless prevented by bedrock or rock content of soils); pulling berm; pulling slash (where available); planting or seeding disturbed areas with native species that naturally occur in the project planning area to achieve a minimum of 35% ground cover; restoring natural drainage patterns and waterbarring as needed; and/or disguising the first hundred yards of travel way with large pieces of organic material such as cull logs and tops of trees. Methods will be determined in consultation with a hydrologist, fisheries biologist, or soil scientist.	Road decommissioning	Engineer, or contracting & sale administrator
Aquatic and Watershed -25	Erosion control	Utilize erosion control measures (sediment filters or straw bales) and operate machinery only on road prism during road construction, maintenance and road decommissioning activities.	Road maintenance decommissioning and new road construction	Engineer, or contracting & sale administrator
Aquatic and Watershed -26	Erosion control	Locate temporary roads outside sediment delivery zones (determined by soil type, ground vegetation, and slope), meet best management practices for controlling surface runoff and erosion, and keep machinery on approved roadway.	Temporary road and landing construction	Engineer, or contracting & sale administrator
Aquatic and Watershed -27	Erosion control and wildlife habitat preservation	Obliterate temporary roads by some combination of the following: recontouring slopes (removing cut and fill slopes); subsoiling (loosening) compacted soils in a “J” pattern to a depth of 16 inches (unless prevented by bedrock or rock content of soils); pulling berm; pulling slash (where available); planting or seeding disturbed areas with native species that naturally occur in the project planning area to achieve a minimum of 35% ground cover; restoring natural drainage patterns and waterbarring as needed; and/or disguising the first hundred yards of travel way with large pieces of organic material such as cull logs and tops of trees. Methods will be determined in consultation with a hydrologist, fisheries biologist, wildlife biologist, or soil scientist.	Temporary road and landing construction	Engineer, or contracting & sale administrator
Aquatic and Watershed -28	Erosion control	Landings/staging areas will not be located within riparian habitat conservation areas (RHCAs) unless located on existing landings or utilizing an area approved by the Aquatics Staff.	Landings	Timber sale administrator, Aquatics Staff

Criteria number	Objective	Design Criteria	Areas, units, or activity type	Responsible person
Aquatic and Watershed -29	Erosion control	Minimize amount of blading on closed roads with good grass cover present, unless a gulley or safety is present.	Timber haul	Timber sale administrator
Aquatic and Watershed -30	Protection of watershed resources	Timber harvest will not occur within RHCAs, unless identified as an aquatic restoration unit.	Timber felling	Timber sale administrator, layout
Aquatic and Watershed -31	Forest restoration, protection of watershed resources	Skyline yarding corridors (sky roads) and tailholds are permitted across streams. Corridors must be less than 12 feet wide, spaced greater than 100 feet apart when crossing the stream, as close to perpendicular to the channel as possible, and can range from 350 to 1000 feet in length.	Timber yarding	Timber sale administrator
Aquatic and Watershed -32	Protection of watershed resources	Require one end suspension on >90% of skyline logging corridors. Logs will be fully suspended over streams.	Timber yarding	Timber sale administrator
Aquatic and Watershed -33	Protection of watershed resources	Heavy equipment is permitted only at designated crossings within the ephemeral draws and stream channels, and approved by a hydrologist or fisheries biologist.	Timber yarding	Timber sale administrator, layout
Aquatic and Watershed -34	Protection of watershed resources	Skyline corridors shall be oriented perpendicular across ephemeral draws, not running lengthways along them.	Timber yarding	Timber sale administrator
Aquatic and Watershed -35	Protection of watershed resources	No skidding will occur across stream channels (categories 1-4), unless approved by aquatics staff. Logs and slash would be placed at all crossings within channel and floodplain to minimize soil compaction. Once skidding is complete, logs and slash will be spread out across channel and floodplain to minimize bare ground and maintain water quality.	Timber yarding	Timber sale administrator, aquatics staff

Alternative 1 – No Action

Direct and Indirect Effects

Riparian

Under the no action alternative, wildfire suppression would continue to impact riparian conditions and the conifer canopy would continue to close, increasing regeneration of late seral species in the understory. The higher canopy cover would prevent sunlight from penetrating into the lower canopy levels and the forest floor. It would suppress the vigor and growth of individual large trees, vegetation development in the understory, and future recruitment of structural wood in the stream channels.

Future recruitment of persistent large trees in stream channels is an integral component of sediment storage, channel complexity, increased cold water storage (hyporheic flow), and provides good aquatic habitat. Reduced vigor occurs due to the increased competition, and damage that may occur from insects, predominantly. Late seral species (grand fir) would continue to outcompete other tree species in the closed canopy conditions. Grand fir is known to be less resistant to insects and disease and typically decays at a much faster rate than ponderosa pine and western larch when lying on the ground.

Riparian hardwood communities, including aspen, cottonwood, alder, and birch would continue to decline from competition with conifers due to fire suppression and altered hydrology caused by channel incision and lack of floodplain connectivity. These communities would continue to decline until a fire event occurs. Riparian hardwoods would continue to be increasingly deficient across the Blue Mountains.

Beaver trapping and impairment in floodplain connectivity would continue to restrict channels from being connected to their floodplains. During peak flows events, water is not being inundated to its historical extent. Also, water is routing off faster during these events because of a simplified network of channels. Continued fire suppression would likely continue to infill younger conifer age classes into meadows and may gradually convert some of the meadows into forests. Gullies would continue to drain water off the meadows faster, decrease the area for hydric plant communities to occur, and limit water storage that could attenuate base flow. As a result, the natural timing and variability of the water table elevations in meadows has been disrupted. This effect has also occurred in riverine wetlands adjacent to streams where floodplain connectivity has been disturbed.

Stand density index

The no action alternative is expected to further decrease the health of riparian stand conditions and their ability to provide riparian processes and functions. These stands would not be resilient to wildfire, insects, and disease. Stand density index, as discussed in the existing condition, is an important indicator of stand health. The no action alternative would increase the acres of stands within various management zones (see Table 14).

- In the Warm Dry plant association group, 2,586 acres are above the management zone and would increase by 228 acres in 2035, and 349 acres in 2055 from the existing condition.
- In the Cool Moist plant association group, 943 acres are above the management zone and would increase by 12 acres in 2035, and 71 acres in 2055 from the existing condition.
- In the Cold Dry plant association group, 393 acres are above the management zone would increase by 29 acres in 2035, and 53 acres in 2055 from the existing condition.

Table 14 Stand density index management zones for the three most common plant association groups found in riparian habitat conservation areas within the planning area

Stand density index stocking level	Existing condition (acres)	Condition in 2035 (acres)	Condition in 2055 (acres)
Warm Dry above the management zone	2,586	2,814	2,934
Warm Dry within the management zone	290	192	220
Warm Dry below the management zone	300	170	22
Cool Moist above the management zone	943	956	1,014
Cool Moist within the management zone	23	127	117
Cool Moist below the management zone	165	49	0
Cold Dry above the management zone	393	422	445
Cold Dry within the management zone	40	26	21
Cold Dry below the management zone	34	19	1

Crown fire initiation

The no action alternative would continue to increase basal areas and fuel accumulations in riparian areas until mortality changes alter crown fire over time. Ground and ladder fuels would be more uncharacteristic of historical fire behavior in the riparian areas due to the lack of structural complexity and linkages in contagious fuels. Riparian areas providing shade as an important ecosystem function of maintaining high quality fish habitat in these tributary streams would continue to be at risk. Crown fire initiation, as discussed in the existing condition, is an important indicator of wildfire occurrence removing stream shade. Implementation of the no action alternative would change the acres of stands within high, very high, and extreme crown fire initiation classes, but not meaningfully reduce the amount of land in the higher rating classes (see Table 15).

- In the Warm Dry plant association group, 2,144 acres are in the high, very high, and extreme crown fire initiation classes and would decrease by 414 acres in 2035, and 389 acres in 2055 from the existing condition.
- In the Cool Moist plant association group, 814 acres are in the high, very high, and extreme crown fire initiation classes and would decrease by 101 acres in 2035, and 140 in 2055 from the existing condition.
- In the Cold Dry plant association group, 302 acres are in the high, very high, and extreme crown fire initiation classes and would decrease by 19 acres in 2035, and increase by 2 acres in 2055 from the existing condition.

Table 15. Crown fire initiation for three most common plant association groups found in riparian habitat conservation areas within the planning area

Stand density index stocking level	Existing condition (acres)	Condition in 2035 (aces)	Condition in 2055 (acres)
Warm Dry: high, very high, and extreme	2,144	1,730	1,756
Warm Dry: medium	918	1,347	1,272
Warm Dry: low	113	99	149
Cool Moist: high, very high, and extreme	814	713	674
Cool Moist: medium	295	414	435
Cool Moist: low	22	3	22
Cold Dry: high, very high, and extreme	302	283	304
Cold Dry: medium	158	184	143
Cold Dry: low	7	0	20

The no action alternative would degrade riparian/wetland vegetation condition, particularly for the forested riparian zone for all three subwatersheds to poor condition ratings by 2035 and into 2055. Riparian stands are filling in with late seral species that are not appropriate for a fire-adapted landscape in densities that may burn larger areas, hotter. These important stands would not be resilient towards wildfire, flooding, insects, and disease disturbance regimes. Native vegetation reflective of frequent fire disturbances and occur in diverse age and structure, and cover would be less than 25 percent of the riparian or wetland area.

Large Wood and Stream Channels

Implementation of the no action alternative would maintain stream channels in their current conditions. The no action alternative would maintain the current riparian stand conditions and low rate of large wood recruitment in stream channels. Indirect effects could occur as riparian stands decline, leading to an increase in large wood recruitment in streams. Size of wood in its recruitment zone typically determines the effect of the wood within the stream. Site visits indicate smaller size materials would be recruited to the streams in the Camp Lick planning area.

Channel incision from past beaver trapping, railroad grade levee construction, and historical livestock grazing have affected the process of floodplain connectivity the greatest in meadow streams. Another impact is from past timber harvesting in forested riparian areas. This has removed wood recruitment that would provide roughness to the stream channels. During peak flows, having access to a floodplain puts the reach in balance with the sediment and water inputs. This allows the width/depth and bank angle to form and be maintained in balance with stressors (shear stress) acting on it. As a result, the current channel would continue to be free of wood and have extra stream power that transports the gravel sized material out of the reaches. The capture and storage capacity of gravels is critical to form quality pools frequently located throughout the reach. The channel form (e.g., width/depth) and floodplain connectivity would likely not change within the next 50 years. Since wood would fall in over time, minor changes would occur to pool quality (i.e., residual pool depth) and quantity (i.e., pool frequency) thereafter.

Stream channel form and function for Lick Creek subwatershed would stay in a “fair” condition because it is more controlled by rock through its Rosgen B channel form. Upper Camp Creek and Lower Camp Creek were rated as “poor, impaired condition” due to the channel incision that has downcut the streambed and would continue in its current condition. This is due to the past legacy practices of beaver trapping, railroad grades, and historical grazing. Fire suppression management actions interrupted stand replacing wildfire in headwater sources zones. As a result, upland sediment supply processes have been paused due to the cascading impacts of wildfire suppression. Overall, the stream channels are on the low end of their historical range of variability. Various stream channels would continue to be departed from the desired conditions.

Large wood levels in many of the creeks would continue to stay below forest plan standards. All three subwatersheds would be in the poor condition class for large wood into the future. This would continue until a wildfire occurs and the wood breaks down to a condition where it interacts with the channel. As a result, the terraces that were recently a floodplain would remain dry and unconnected to the water table.

Water Quality (Temperature and Biocriteria)

Implementing the no action alternative would gradually degrade water quality in its current condition and into the future. Changes to water temperature are largely driven by air temperatures, streamflow, and effective shade from vegetation, channel form, and adjacent hillslopes. The no action alternative would maintain the current channel form and riparian stand conditions. Shade is not expected to change, unless a moderate or high severity wildfire occurs. If the canopy is reduced, a large temperature spike would occur to the area affected for 5 to 10 years. Riparian hardwoods could reestablish and provide canopy closure if the fire intensity was conducive and the seed source was present, or vigor of the hardwoods good.

The Tower wildfire on the Umatilla National Forest could be an example of the no action alternative. They observed the need to plant riparian hardwoods to establish shade following the wildfire, likely because the riparian hardwoods were not in a resilient condition to respond to the wildfire impacts and re-sprout quickly (see Figure 20). This lapse in stream shade in the Camp Lick planning area could negatively impact water temperatures from providing beneficial uses to aquatic species.

Figure 20. Photograph of Texas Bar Creek in the Tower wildfire area showing a lack of natural riparian hardwood recruitment

The biggest influence of climate change on water temperature relates to changing snowpack conditions. Under the no action alternative, baseflow conditions could continue to degrade further in the face of climate change. The climate change scenarios currently project a 3 to 4 degree Celsius increase in air temperatures by 2080. Air temperatures are expected to only gradually increase by 2040. This would likely affect the vulnerability of snowpack in the planning area and transition portions of the planning area from a snow to rain dominated hydrologic regime. As a result, more peak flows would occur during the winter, with less water being present during baseflows. Estimates suggest that there could be 0 to 30 percent declines in baseflows because of this climatic change process (Blue Mountains Adaptation Project 2014). Peak flows and base flows would continue to stay departed from their landscape potential and be outside of their historical range of variability.

Cumulative Effects

Under the no action alternative, there would be no management activities associated with timber harvest, prescribed fire, riparian restoration, fence construction, recreation interpretive site development, and associated road activities in the planning area; therefore, there would be no direct effects to riparian conditions, large woody debris, stream channel shape and function, and water quality. There would continue to be ongoing effects from the past, present, and reasonably foreseeable future actions.

The hazard of an uncharacteristic wildfire in a riparian area would be higher, as described in the Fire, Fuels, and Air Quality Report. Most of the forested stands in both riparian areas and the uplands within the planning area are overstocked and have been identified as a moderate to high risk for insect and disease mortality. Without silvicultural treatment and/or the controlled re-introduction of fire into the planning area, current stand conditions would worsen and increase the chance of a stand replacing fire. A stand replacing wildfire would result in the loss of shading along stream channels, loss of instream wood structures, and short-term (3 to 5 years) loss of streamside vegetation. Water temperatures would increase, for perhaps one to a few decades, depending on riparian shrub and tree recovery. Sediment from upland sources could increase for 1 to 3 years following a fire. Sediment from channel sources could increase due to higher peak flows and loss of stabilizing trees and shrubs. There would be increased sediment from channel sources for approximately 5 years until bank stabilizing vegetation has recovered. Severe fire would also supply an extended pulse of woody debris to streams, which would gradually decay over decades.

The effects from past practices which include timber harvesting, fire suppression, livestock grazing, road construction, wildfire, beaver trapping, and railroad grade construction have created stream channels and meadows that are incised and lack floodplain connectivity across the planning area. Taking no action to add large and coarse woody debris or restore forested riparian stands would keep riparian/wetland conditions, large woody debris, stream channel shape, and water quality departed from desired future conditions.

Reasonably foreseeable future actions under the Aquatic Restoration Decision actions of legacy structure removal, riparian vegetation planting, wet meadow restoration, beaver habitat restoration, and large and coarse woody placement may occur. These treatments would enhance the larger streams in the drainage and improve their floodplain connectivity. However, if these treatments do occur and good habitat was present, it may be decreased by a wildfire occurring in the headwaters.

Alternative 2 – Proposed Action

Direct and Indirect Effects – Silviculture Treatments, Fire Treatments, Interpretive Sign Installation, Range Fence, and Road Activities

Riparian, Large Wood, Stream Channel Shape, Water Quality

Stand improvement commercial thinning (8,700 acres), lodgepole treatments (600 acres), stand improvement biomass thinning (2,250 acres), western white pine restoration (150 acres), juniper encroachment treatments (730 acres), biomass removal, and strategic fuel breaks would have indirect effects that would benefit riparian conditions. This would occur by decreasing stand densities and reducing fuels adjacent to riparian areas, ultimately improving stand health and impacting wildfire behavior coming into riparian areas. Juniper and ponderosa pine have expanded onto hillslopes altering the duration of soil moisture and decreasing the grass cover present. Reducing grand fir and juniper may also increase runoff later into the growing season for adjacent riparian areas and promote growth. These treatments however would not have any direct effects to riparian/wetland conditions, large wood, stream channel shape, water quality, water temperature, and biocriteria, and would therefore not change the condition for these resources.

Road activities would influence riparian conditions, but will be discussed in the hydrologic function section. Interpretive signs would be placed in the RHCA of Camp Creek and may impact ground cover, but would have no impact to riparian conditions.

The proposed action includes two range fences that would be constructed to better control livestock. The fence would be constructed for approximately 1.7 miles around Cougar Creek, crossing a category 1 RHCA twice and crossing three category 4 RHCAs. The other 1.7 mile segment along the Upper Camp Creek would cross two category 4 streams and border the outside edge of a category 1 RHCA. Direct and indirect effects from these fences would impact ground cover along the trail and any trees or shrubs along the path. Project design criteria were developed to minimize impacts to riparian management objectives for shade and wood as a result of this treatment. The project would not remove any wood or fell trees towards the stream that may need to come down as a result of fence construction. Impacts to shade would be minimized by minimizing any removal of hardwoods.

Direct and Indirect Effects – Riparian and Upland Watershed Restoration Treatments

Riparian

Implementing the aspen restoration (approximately 80 acres) and ecological riparian treatments (approximately 2,300 acres) portions of the riparian and upland watershed restoration treatments may have a short-term adverse direct effect on riparian canopy cover through managing tree density and reducing late seral species in openings and variable density portions of treatment areas. The goal would be to improve riparian forest stand health through implementing a silvicultural prescription that mimics wildfire patterns and puts stand densities within the management zones for stand density index (SDI). This treatment is expected to accelerate mortality processes and increase growth and recruitment in residual desired early seral species. Treated areas would be more resilient to drought and wildfire disturbances, as illustrated by the SDI and crown fire initiation indicators, than the no action alternative. Decreases in the canopy would result in less interception losses of rain and snowmelt and increased snow redistribution, resulting in a slower snowmelt. Lowered tree densities would also decrease transpiration demands of conifers and improve riparian hardwood cover and diversity, particularly where water tables are elevated and plants have access to soil water during the entire growing season.

Ecological riparian treatments may occur on 2,300 acres in the planning area. Activities proposed include tipping and felling the large woody debris into creeks. Tipping actions may be completed with heavy equipment that would reduce ground cover in riparian floodplains where treatments are proposed. The reduction of ground cover adjacent to the creek, on the floodplain, poses a water quality risk for sediment inputs. This would be reduced through implementation of project design criteria including rehabilitation of all disturbed areas after work activities have been completed, using seed mixes, jute matting, adding slash cover, or other techniques. The direct and indirect effects to riparian conditions from implementing the riparian restoration activities would restore the potential natural vegetation that is identified in the John Day TMDL.

Table 16. Riparian habitat conservation areas by subwatershed with total acres, acres proposed for treatment, and percent proposed for treatment

Subwatershed	Acres of riparian habitat conservation area	Acres of riparian habitat conservation area treatments	Percent of riparian habitat conservation area proposed for treatment
Lick Creek	1,660	760	46%
Lower Camp Creek	1,510	520	34%
Upper Camp Creek	2,910	960	33%

Some units are located on hillslopes in sub-drainages which have been previously disturbed by management activities increasing the chance that impacts from previous disturbance would become connected to ground disturbance associated with the proposed actions. This could possibly extend the drainage network headward (i.e., upstream) or create concentrations of runoff or sediment that could be transported beyond unit boundaries during large, rare runoff events. However, generally overland flow is not expected to be concentrated enough to cause accelerated erosion or to deliver increased sediment to perennial streams in most locations under common rainfall events.

Maintenance of ground cover over much of the area and the filtering and sediment trapping capacity of RHCAs are likely to slow and absorb runoff and trap sediment. Activities in RHCAs would be rehabilitated before the next peak flow event if it poses a water quality risk. Improving the density and species composition of these forested areas in both uplands and riparian areas would improve the long-term condition of streamflow during the lowest part of the year, baseflows.

Stand density index

These treatments are expected to improve riparian stand conditions and their ability to provide riparian processes and functions, yet also be resilient to unplanned ignition wildfires. The goals of riparian treatments are to restore the natural potential vegetation of riparian systems. Stand density index (SDI), as discussed in the existing condition, is an important indicator of stand health. Implementation of the proposed action would reduce the acres of stands above the management zone in the three most dominant plant association groups found in riparian habitat conservation areas in the planning area (see Table 17).

- In the Warm Dry plant association group, 2,586 acres are above the management zone and would be reduced by 740 acres immediately after treatment, 345 acres in 2035, and 254 acres in 2055 from the existing condition.
- In the Cool Moist plant association group, 943 acres are above the management zone and would be reduced by 260 acres immediately after treatment, 209 acres in 2035, and 159 acres in 2055 from the existing condition.
- In the Cold Dry plant association group, 393 acres are above the management zone and would be reduced by 185 acres immediately after treatment, 139 acres in 2035, and 108 acres in 2055 from the existing condition.

Table 17. Stand density index management zones for the three most dominant plant association groups found in riparian habitat conservation areas within the planning area

Stand density index stocking level	Existing condition	Condition after proposed action	Condition in 2035	Condition in 2055
Warm Dry above the management zone	2,586	1,846	2,240	2,331
Warm Dry within the management zone	290	559	252	316
Warm Dry below the management zone	300	768	681	526
Cool Moist above the management zone	943	684	735	785
Cool Moist within the management zone	23	106	136	171
Cool Moist below the management zone	165	358	277	192
Cold Dry above the management zone	393	208	253	285
Cold Dry within the management zone	40	93	104	96
Cold Dry below the management zone	34	165	106	85

Crown fire initiation

The proposed action would reduce basal areas and fuel accumulations in riparian areas. Reducing ground and ladder fuels would be more representative of historical fire behavior in the riparian areas, creating conditions consistent with a mixed severity fire regime. Ensuring forests maintain appropriate cover and provide shade is an important ecosystem function of maintaining high quality fish habitat in these tributary streams. Riparian treatments are proposed in reaches that are thermally important to maintain shade, where hillslopes are naturally more active, and where fish habitat is inherently higher quality. These reaches were identified using the NetMap decision support system. The top 25 percent of most thermally important reaches were selected for treatment. They provide the top 25 percent of forested reaches where if the canopy was removed, solar loading gains would be the greatest. Also, the top 25 percent of reaches where NetMap’s generic erosion potential identifies reaches downstream of potentially erodible hillslopes. Crown fire initiation, as discussed in the existing condition, is an important indicator of wildfire occurrence removing stream shade. Implementation of the proposed action would reduce the acres of stands within crown fire initiation classes (see Table 18).

- In the Warm Dry plant association group, 2,144 acres are in the high, very high, and extreme crown fire initiation classes and would be reduced by 1,464 acres immediately after treatment, 1,423 acres in 2035, and 1,292 acres in 2055 from the existing condition.
- In the Cool Moist plant association group, 814 acres are in the high, very high, and extreme crown fire initiation classes and would be reduced by 452 acres immediately after treatment, 399 acres in 2035, and 365 acres in 2055 from the existing condition.
- In the Cold Dry plant association group, 302 acres are in the high, very high, and extreme crown fire initiation classes and would be reduced by 205 acres immediately after treatment, 159 acres in 2035, and 185 acres in 2055 from the existing condition.

Table 18. Crown fire initiation classes for the three most dominant plant association groups found in riparian habitat conservation areas within the planning area

Crown fire initiation class	Existing condition	Condition after proposed action	Condition in 2035	Condition in 2055
Warm Dry: high, very high, and extreme	2,144	680	721	852
Warm Dry: medium	918	1,449	1,394	1,404
Warm Dry: low	113	1,044	1,058	918
Cool Moist: high, very high, and extreme	814	362	416	450
Cool Moist: medium	295	449	370	331
Cool Moist: low	22	337	362	367
Cold Dry: high, very high, and extreme	302	98	143	117
Cold Dry: medium	158	231	156	205
Cold Dry: low	7	137	167	144

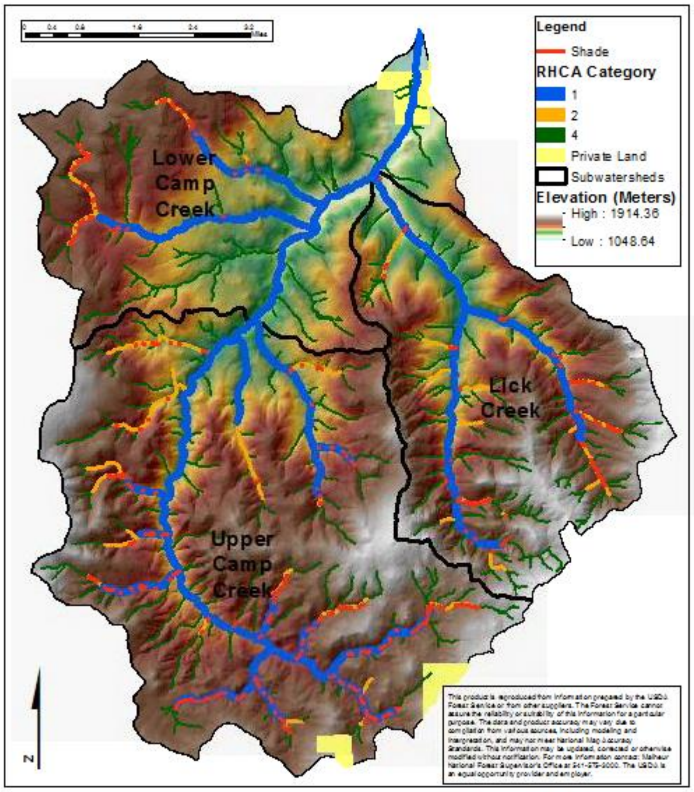

Figure 21. Map illustrating portion of stream network that is the top 25 percent most thermally sensitive to loss in forest canopy within the Camp Lick planning area

Meadow Riparian

Implementing the meadow restoration (approximately 115 acres) restoration treatments may have a short-term adverse direct effect on ground cover as materials are transported to the meadow's gullies, but would improve the condition of the riparian plant communities associated with the meadow and improve meadow function over the long-term (10 to 15 years). The structure of trees around the perimeter of the meadow would resemble historical fire patterns and would be resilient if an unplanned ignition occurs. Additions of coarse and large woody debris to the gullies and streams would help increase roughness elements and elevate water tables, providing habitat for hydric plants.

The proposed action would place the riparian/wetland vegetation condition on a trajectory towards a "good" condition rating in line with desired conditions for all three subwatersheds after the implementation of riparian thinning and prescribed fire treatments. That would be an improvement from the "fair" condition rating in the existing condition that would otherwise be maintained by the no action alternative. A mosaic of diverse age classes, structural complexity, and cover provided by riparian hardwoods, with species composition that would have dense pockets of grand fir with large ponderosa pine trees and patches of larch would increase. Riparian stands would be more resilient to wildfire, flooding, and windthrow disturbances and able to maintain early seral seed sources when disturbance does occur. Increased openings may improve riparian hardwood and age class distribution across the planning area and increase nutrient inputs and food webs to the aquatic system.

Large Wood and Stream Channel Shape

Implementing treatments in riparian habitat conservation areas (RHCAs) may have a short-term positive direct effect on instream wood loads and a long-term positive indirect effect on large wood recruitment. The existing condition for large wood identified many stream reaches that are far below Forest Plan standards. Large wood loads instream would be increased by the project design criteria that all trees felled (or tipped) within 100 feet would be left on site or placed instream to meet desired conditions. Large woody debris loads would increase mostly through implementation of the opening treatments. Coarse and large wood would be placed instream to provide hydraulic roughness, capture sediment, and aggrade the stream channel. Wood represents debris roughness that provides more floodplain connectivity and promotes pool formation. Wood also creates instream jams that capture detritus and organic matter, spiral nutrients, and provide water flows through the streambed (hyporheic flow), incrementally cooling the water temperature. Large trees may be placed instream from the outer portion of the RHCA until the riparian management objectives of different wood size classes are met for each proposed reach. Future wood recruitment would be enhanced through managing for early seral species (e.g., ponderosa pine and western larch), which persist instream longer, and influences stream channel shape and habitat quality more than other tree species. The untreated portion of the stream network would gradually see an increase in large wood as it is recruited in at a slower rate. Coarse and large wood would not be commercially harvested in the inner 50 feet of each side of the stream in category 4 RHCAs to improve coarse and large wood loads.

Implementing headwaters restoration treatments (approximately 200 acres) may have a long-term positive indirect effect on sediment supplies and transport through the stream network if a thunderstorm or rain on snow event occurs over the treated areas. If gulley erosion is produced, a pulse of sediment built up in valley storage would be moved downstream with each snowmelt runoff flood event. The majority of sediment would be deposited within a depositional reach in Camp Creek, likely 20 years following prescribed fire treatments. The sediment would be stored behind large wood and would create step pools in transport reaches and help narrow channel widths. Silt would be stored behind beaver dams or on floodplains where connected, and gravels would then be available for spawning. This sediment would help narrow and improve stream channel shape and provide the materials needed to form high quality aquatic habitat.

As a result of the proposed action, all three subwatersheds would be rated as “good” condition for large woody debris and “good” for stream channel shape. The forested stream network would contain large wood in many more reaches in the planning area, especially reaches downstream of hillslopes that are geologically more active and provide materials to create complex aquatic habitats. Reaches proposed for treatment would meet Forest Plan riparian management objectives after treatment that are deficit in the existing condition.

Water Quality

There is low potential for increased inputs of point and non-point source pollutants as a result of silvicultural treatments. Project activities with potential to affect water quality from the silvicultural treatments include timber haul and log skidding:

- Equipment operations in riparian areas or close proximity to water have the potential for accidental spill of petroleum products.
- Timber haul can affect sediment delivery when accomplished during wet conditions.
- Log skidding can create compacted surfaces that create pathways for sediment laden water.

Best management practices would be utilized and project design criteria are prescribed for each of the following activities to prevent or mitigate these effects.

- Before working in a RHCA, equipment inspections and monitoring would be conducted to assure there are no hazardous fluid leaks when operating.
- An Oil and Hazardous Substance Spill Contingency Plan and Spill Prevention Control and Countermeasures (SPCC) Plan would be prepared and counter measures put into place to capture potential leaks or spills during operations.
- Equipment servicing and refueling practices would be designed to prevent accidental spills from entering riparian area or water.
- Haul would occur only during conditions that support proper road use.

Temperature

During implementation of the aspen restoration (approximately 80 acres) and ecological riparian treatments (approximately 2,300 acres), portions of the riparian and upland watershed restoration treatments may have a short-term (2 to 5 years) adverse direct effect on effective shade and water temperature locally. Trees felled or tipped in the shade zone would be directed towards the stream where they would provide immediate shade in or over the stream. Openings may occur within 10 to 20 percent for the Cool Moist plant association group, and 20 to 30 percent for the Warm Dry plant association group. Openings created on perennial streams with the intent of restoring the riparian hardwoods would be prone to heating during the transition from conifer shade to riparian hardwood shade. Shade loss would be mitigated by prioritizing opening locations where riparian hardwoods are already established and by placing trees over browsed shrubs. If monitoring identifies that ungulate browse is not allowing multiple age classes of aspen or riparian hardwoods to grow, then a fence may be constructed around the riparian shrubs or trees. Direct and indirect effects of fence construction around hardwoods may impact ground cover locally around where fence posts are inserted into the ground. PDCs are present to minimize removal of stream shade during fence construction.

The ecological riparian treatments and aspen restoration would reduce canopy closure and shade in patches over the short-term to allow light to reach the riparian shrub and tree understory (e.g., willows, alder, cottonwood, and aspen). These patches would provide riparian hardwood shrubs and trees to expand in age classes and extent. They are designed to emulate natural disturbance processes and patch creation inherent to these riparian systems from natural wildfire, windthrow, and flood.

Table 19. Riparian habitat conservation areas by stream category and acres proposed for treatment

Subwatershed	Riparian habitat conservation area category	Acres of riparian habitat conservation area treatments
Lick Creek	1	603
Lick Creek	2	102
Lick Creek	4	50
Lower Camp Creek	1	262
Lower Camp Creek	2	79
Lower Camp Creek	4	178
Upper Camp Creek	1	599
Upper Camp Creek	2	259
Upper Camp Creek	4	104

A linear strip of alder, dogwood, maple, willow, and other riparian hardwood vegetation currently exists along the majority of proposed reaches and would widen to the toe of the hillslope, particularly for unconfined and moderately confined valley types. Riparian hardwoods would increase in growth following prescribed wildfire and the associated increase in available nutrients.

Treatments would reduce conifer shading in patches and may have pockets (less than one acre) of shade loss for 1-2 growing seasons until the riparian hardwoods present respond to the changed conditions. Consequently, water temperatures in streams near these activities are expected to warm locally; however, the change may not be measurable at the 6th field subwatershed scale due to the patchy and limited spatial extent of the activities. While shade may be slightly diminished over the short-term, adding wood and increasing hyporheic flows may incrementally cool base streamflows. The net result of the proposed action improve the health of riparian stands, defined through a reduction in stand density index stocking levels and crown fire initiation. This would improve resilience to wildfire for treated and adjacent riparian areas. Improving conditions would ensure tributaries provide cold water inputs from their spring sources to downstream high quality aquatic habitat.

Biocriteria

Direct and indirect effects from ecological riparian treatments and aspen restoration are expected to beneficially influence macroinvertebrate communities (e.g., biocriteria). Recent investigations have linked the benefits of riparian hardwoods and their leaf fall to soil structure and the primary and secondary productivity inputs to the stream network. Leaf fall benefits soil structure by increasing the amount of organic matter that is broken into the soil horizon. This improves the water holding capacity of the soils and the functions of the riparian areas. Furthermore, the increase in primary productivity influences macroinvertebrate communities. Indirect effects to biocriteria include moving the observed number of species closer to the expected number of species within 10 years as riparian conditions recover.

Cumulative Effects

Past, present, and reasonably foreseeable future activities that were considered for the Watershed Report include: timber harvesting and sales; plantation maintenance; insect and disease outbreaks; past wildfire and fire suppression; riparian enhancement and channel restoration; riparian plantings; range fence exclosures; dispersed camping; hiker, horse, and foot trail; cross country OHV use; past, present and foreseeable livestock grazing; transportation activities; and firewood cutting. Foreseeable future actions involving the Aquatic Restoration Decision include restoration to three of the headwater wet meadows, riparian hardwood plantings and fence exclosures, beaver dam analogues construction, placing coarse and large woody debris instream, and removing portions of an old railroad grade levee that constrains Camp Creek. Uses occurring on private lands includes irrigation withdrawals, livestock with stream fence exclosures, water gaps on Camp Creek, timber management, and fire suppression. The geographical scale analyzed for cumulative effects extends down to the junction of Camp Creek and the Middle Fork John Day River.

Since direct or indirect adverse effects from the proposed silvicultural treatments are expected to remain within unit boundaries, during common runoff events, adverse cumulative effects from the proposed activities are not expected. Increased connections from past disturbance may contribute to accelerated erosion over larger areas. Additional ground cover from slash and seed would be applied to all disturbance paths in riparian habitat conservation areas. Within 5 years after project activities are implemented, additional flows and sediment may reach the Middle Fork John Day River following rare run-off events. Increases in run-off would not be measurable compared to the magnitude of the response under alternative 1 and the variability associated with measuring watershed attributes.

Modifying vegetation and other conditions influencing fire behavior in the planning area may reduce fire intensity as described in the Fire, Fuels, and Air Quality Report and improve watershed resiliency in adjacent areas. Fire behavior is expected to change from uncharacteristically high to characteristically low intensity; ground disturbing effects from either uncharacteristic wildfire itself or suppression activities are expected to be reduced. Consequently, cumulative interactions between these effects and those of legacy disturbances are expected to be reduced, resulting in a reduction in watershed hazard.

Implementing proposed ecological riparian treatments on approximately 2,300 acres would move the treated reaches towards the natural potential vegetation types and reduce cumulative effects by restoring physical processes and ecological functions. The ecological riparian treatments may have a measureable effect locally to effective shade and water temperature over the short-term, but not to water temperature at the 6th field subwatershed scale. The materials provided from ecological riparian treatments would be utilized for the proposed large woody debris placement treatments. The coarse and large wood inputs would provide the structure to capture gravels and increase the sediment storage functions that build the streambed and drive aggradation processes over time. Capturing the sediment and storing it around the woody materials would aid in providing floodplain connectivity and improve the water storage of these valley bottoms and meadows to yield more baseflows later into the year. As gravel fills in the channel and it reaches its capacity, more water would fill the void space between gravel particles and gradually cool the water as it moves downstream and remixes with surface water. This is known as hyporheic flow and this process decreases water temperature and may be beneficially measureable from the large woody debris additions. However, there would be a balance between potentially increasing water temperatures by opening the forest canopy in patches to improve the riparian shrub communities, and the expected cooling of that water caused by increased hyporheic flow. The additional water storage from the floodplains and meadows would also work to cumulatively cool the water. In addition, the improved leaf fall and productivity from restoring riparian shrub communities would boost the macroinvertebrate communities downstream. Improving the organics in this soil structure may also increase baseflows.

These projects are designed to:

- Restore areas damaged by past timber activities that have removed large woody debris from creeks and riparian areas.
- Emulate natural disturbance regimes that would increase the distribution and species composition of riparian hardwoods hindered by past and current fire suppression tactics.
- Restore the expected channel dimensions, patterns, and profiles that have been altered from past activities.
- Restore meadows and streams that have been altered by historical grazing.

These projects combined with past watershed restoration projects in other locations in the cumulative effects analysis area would contribute to the cumulative recovery of the Lower Camp Creek, Upper Camp Creek, and Lick Creek subwatersheds. Riparian and wetland conditions across forested and meadow riparian areas would be in “good” conditions. Large woody debris and stream channel shape would be in a “good” condition, particularly after a debris flow provided sediment that filtered through Camp Creek (25 years). Water quality would also be in “good” condition as meadow riparian areas progress towards willow and cottonwood shrub communities and riparian hardwoods occur more frequently in forested riparian areas. Riparian hardwoods would provide abundant leaf fall that would improve macroinvertebrate communities.

Compliance with Forest Plan and Other Relevant Laws, Regulations, and Policies

Forest Plan

This project is consistent with Malheur Forest Plan direction for water resource protection because it would not measurably increase watershed impacts, including stream temperature, over the existing conditions at the 6th field scale. The "Forest Service R6 General Water Quality Best Management Practices" (USDA Forest Service 1988) would be followed under alternative 2. Interim Strategies of Managing Anadromous Fish Producing Watersheds (PACFISH) standards and guidelines, and Malheur Forest Plan standards that provide direction for riparian buffers were used. For this analysis, Management Area 3B is described through the term riparian habitat conservation area (RHCA) because RHCAs are wider and more conservative.

Additional Malheur Forest Plan and PACFISH standards and guidelines are discussed below:

- Riparian enhancement thinning treatments are consistent with the Malheur Forest Plan, PACFISH Timber Management -1 (TM-1) b: apply silviculture practices for Riparian Habitat Conservation Areas (RHCA) to acquire desired vegetation characteristics where needed to attain Riparian Management Objectives (RMO). Apply silvicultural practices in a manner that does not retard attainment of RMOs and that avoids adverse effects on listed anadromous fish. This standard and guideline would be met for alternative 2 because silvicultural prescriptions are planned for RHCAs in reaches where RMOs were identified to be on the low end of their variability. Many of the reaches have channel incision or floodplain connectivity issues that are driving the low values of RMOs for pool frequency, water temperature, and width/depth ratios. Other reaches were likely harvested for timber and as a result, are on the low end for large woody debris. Adding large woody debris to the stream and floodplain of the reaches treated for riparian enhancement would ensure the reaches are put on a trajectory to attain desired RMOs. Treatments would also ensure riparian forests are resilient to wildfire and drought and provide many ecosystem functions. Riparian forests would provide for riparian hardwoods in various age classes and species diversity to feed aquatic food webs and provide high quality shade and bank stability from their fibrous root system. Alternative 1 would not contribute towards attainment of RMOs.
- Riparian restoration treatments are consistent with the Malheur Forest Plan, PACFISH Watershed and Habitat Restoration – 1 (WR – 1): Design and implement watershed restoration projects in a manner that promotes the long-term ecological integrity of ecosystems, conserves the genetic integrity of native species, and contributes to attainment of Riparian Management Objectives. This standard and guideline would be met for alternative 2 because the design is being focused on the physical processes that need restoration to allow long-term functions to occur. Restoring the conditions in riparian areas would allow disturbance processes to be resilient and maintain its ability to provide high quality aquatic habitat. Alternative 1 would not contribute towards meeting RMOs.

Clean Water Act

This project is consistent with the Clean Water Act and Forest Service responsibilities under the Clean Water Act as described in a Memorandum of Understanding (MOU) with the Oregon Department of Environmental Quality (USDA Forest Service 2014) because it would not measurably increase watershed impacts, including stream temperature, over the existing condition.

The MOU also directs that the Forest Service cannot further degrade water quality impaired streams, although short-term adverse impacts which occur with long-term benefits are allowed. Several streams in the planning area were on the Oregon 303(d) list for above normal stream temperatures, prior to the total maximum daily load being finalized. All alternatives would comply with the Clean Water Act, since none raise stream temperatures, and since all follow best management practices (BMPs) as specified in "Forest Service R6 General Water Quality Best Management Practices" (USDA Forest Service 1988) and "National Best Management Practices for Water Quality Management on National Forest System Lands" (USDA Forest Service 2012).

The Forest Service is directed to comply with State requirements in accordance with the Clean Water Act for protection of waters of the State of Oregon (OAR chapter 34041) through planning, application, and monitoring of BMPs, which are recognized as the primary means to control non-point source pollution on National Forest lands. BMPs would be monitored by the Blue Mountain Ranger District hydrologists, fish biologist, timber sale administrators, and harvest inspectors. The MOU also directs that the Forest Service cannot further degrade water quality impaired streams.

Floodplains (Executive Order 11988)

Executive Order 11988 states that Federal agencies shall avoid adverse effects to floodplains or minimize potential harm. Floodplains several to hundreds of feet wide occur in the planning area. The floodplains are primarily contained within RHCAs. Implementation activities proposed would improve the physical processes of floodplain connectivity and floodplain functions of water storage through being inundated. The proposed action would minimize adverse effects to the floodplains, and thus be consistent with Executive Order 11988.

Wetlands (Executive Order 11990)

Executive Order 11990 states that Federal agencies shall avoid management practices that would adversely affect wetlands. Wetlands that occur in the planning area would be maintained, improved, and expanded in spatial extent with improved function. Focusing on riparian vegetation and channel condition, it would allow increased water storage in the floodplains and is consistent with the executive order protecting wetlands.

Monitoring

The District Hydrologist would establish photo-point monitoring. The objective is to document riparian recovery associated with riparian thinning activities in RHCAs. Monitoring photo-points at 3-year intervals after implementation should indicate whether objectives are being met or if riparian plantings are needed to accelerate recovery of shade. Summer water temperature sites should be continued at the downstream end of Camp Creek reach 1. This should support expected benefits, as effects are observed over the long-term (5 to 15 years).

Best management practice (BMP) monitoring would occur to ensure design criteria and BMPs are being utilized. Methods would be following the USFS National Best Management Practices for Water Quality Management (USDA Forest Service 2012).

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Appendix A

Table 20 (Camp Creek), Table 21 (East Fork Camp Creek), Table 22 (Lick Creek), Table 23 (West Fork Lick Creek), Table 24 (Coxie Creek), Table 25 (Cottonwood Creek), and Table 26 (other tributaries in the Camp Lick planning area) illustrate length, gradient, forest type (used for comparing shade standards), Rosgen bankfull stream type with width/depth ratio, large woody debris, percent of key pieces, shade, and 7 day average daily max stream temperature for stream data collected in 2014.

Table 20. Reach information for Camp Creek

Reach	Reach length (miles)	Gradient (%)	Reach	Forest type	Rosgen stream type / bankfull W/D	Large woody debris / mile	Key pieces (%)	Shade	Stream temperature (degrees Fahrenheit)
1	0.7	0.8	1 desired	Hardwood / meadow	C4/C3 / 13-20	N/A[1]	N/A[1]	80	60.8
1	0.7	0.8	1 current	Hardwood / meadow	C3 / 30	13	22	22	78.2
2	Private property	Unknown	--	---	--	--	--	--	--
3	0.9	2.3	3 desired	Hardwood / meadow	C4/B4 / 13-20	N/A[1]	N/A[1]	80	60.8
3	0.9	2.3	3 current	Hardwood / meadow	C3/B3 / 36	10	0	8	No data
4	3.6	1.9	4 desired	Hardwood / meadow	C3b / 13-20	N/A[1]	N/A[1]	80	60.8
4	3.6	1.9	4 current	Hardwood / meadow	C3b / 29	16	19	48	70.8, 75.2
5	1.7	3	5 desired	Hardwood / meadow	C3b / 13-20	N/A[1]	N/A[1]	80	60.8
5	1.7	3	5 current	Hardwood / meadow	C3b / 22	9	33	22	71.9
6	1.2	2.1	6 desired	Ponderosa pine	B3 / 13-25	20-70	20	40-55	60.8
6	1.2	2.1	6 current	Ponderosa pine	B3 / 21	35	79	27	No data
7	1.9	1.8	7 desired	Hardwood / meadow	C3 / 13-20	N/A[1]	N/A[1]	80	60.8
7	1.9	1.8	7 current	Hardwood / meadow	C3 / 24	25	57	46	76.2, 77.1
8	2.1	2.4	8 desired	Hardwood / meadow	C3b / 13-20	N/A[1]	N/A[1]	80	60.8
8	2.1	2.4	8 current	Hardwood / meadow	C3b / 14	67	39	36	No data
9	2.1	2.3	9 desired	Hardwood / meadow	C3b / 13-20	N/A[1]	N/A[1]	80	60.8
9	2.1	2.3	9 current	Hardwood / meadow	C3b / 14	6	9	19	68.5
10	2.6	2.9	10 desired	Lodgepole pine	C/E3b / <12	100-350	10	60-75	60.8
10	2.6	2.9	10 current	Lodgepole pine	C/E3b / 13	30	17	65	No data
11	1.2	3.2	11 desired	Mixed conifer	E5b / <12	80-120	20	50-65	60.8
11	1.2	3.2	11 current	Mixed conifer	E5b / 6	25	38	80	66

Table 21. Reach information for East Fork Camp Creek

Reach	Reach length (miles)	Gradient (%)	Reach	Forest type	Rosgen stream type / bankfull W/D	Large woody debris / mile	Key wood (%)	Shade	Stream temperature (degrees Fahrenheit)
1	0.9	3.3	1 desired	Mixed conifer	E5b / <12	80-120	20	50-65	60.8
1	0.9	3.3	1 current	Mixed conifer	E5b / 11	31	21	50	No data
2	1.2	No data	2 desired	Mixed conifer	E5b / <12	80-120	20	50-65	60.8
2	1.2	No data	2 current	Mixed conifer	E5b / 11	40	26	49	No data

[1]These are riparian meadow systems where large woody debris standards do not apply

Table 22. Reach information for Lick Creek

Reach	Reach length (miles)	Gradient (%)	Reach	Forest type	Rosgen stream type / bankfull W/D	Large woody debris / mile	Key pieces (%)	Shade	Stream temperature (degrees Fahrenheit)
1	2.6	2.4	1 desired	Mixed conifer	B4 / 13-25	80-120	20	50-65	60.8
1	2.6	2.4	1 current	Mixed conifer	B4 / 23	2	0	36	71.9
2	2.7	4.8	2 desired	Mixed conifer	B4a / 13-25	80-120	20	50-65	60.8
2	2.7	4.8	2 current	Mixed conifer	B4a / 14	2	80	27	60.1
3	1.6	7.6	3 desired	Mixed conifer	B5a / 13-25	80-120	20	50-65	60.8
3	1.6	7.6	3 current	Mixed conifer	B5a / 8	7	36	46	No data

Table 23. Reach information for West Fork Lick Creek

Reach	Reach length (miles)	Gradient (%)	Reach	Forest type	Rosgen stream type / bankfull W/D	Large woody debris / mile	Key pieces (%)	Shade	Stream temperature (degrees Fahrenheit)
1	2.8	2.4	1 desired	Mixed conifer	No data	80-120	20	50-65	60.8
1	2.8	2.4	1 current	Mixed conifer	No data	38	48	55	71.1
2	3	4.8	2 desired	Mixed conifer	No data	80-120	20	50-65	60.8
2	3	4.8	2 current	Mixed conifer	No data	37	60	79	No data
3	0.6	7.6	3 desired	Mixed conifer	No data	80-120	20	50-65	60.8
3	0.6	7.6	3 current	Mixed conifer	No data	60	0	87	No data

Table 24. Reach information for Coxie Creek

Reach	Reach length (miles)	Gradient (%)	Reach	Forest type	Rosgen stream type / bankfull W/D	Large woody debris / mile	Key pieces (%)	Shade	Stream temperature (degrees Fahrenheit)
1	2	3.3	1 desired	Mixed conifer	No data	80-120	20	50-65	60.8
1	2	3.3	1 current	Mixed conifer	No data	17	70	44	66.8
2	0.9	No data	2 desired	Mixed conifer	No data	80-120	20	50-65	60.8
2	0.9	No data	2 current	Mixed conifer	No data	33	20	25	No data

Table 25. Reach information for Cottonwood Creek

Reach	Reach length (miles)	Gradient (%)	Reach	Forest type	Rosgen stream type / bankfull W/D	Large woody debris / mile	Key pieces (%)	Shade	Stream temperature (degrees Fahrenheit)
1	1.1	5.1	1 desired	Ponderosa pine	B3a / 13-25	20-70	20	40-55	60.8
1	1.1	5.1	1 current	Ponderosa pine	B3a / 14	18	45	79	62.4
2	1.3	3.5	2 desired	Ponderosa pine	C3b / 13-20	20-70	20	40-55	60.8
2	1.3	3.5	2 current	Ponderosa pine	C3b / 17	5	83	65	No data
3	0.9	2.2	3 desired	Mixed conifer	C3b / 13-20	80-120	20	50-65	60.8
3	0.9	2.2	3 current	Mixed conifer	C3b / 12	12	54	96	No data
4	2.3	9.1	4 desired	Mixed conifer	B3a / 13-25	80-120	20	50-65	60.8
4	2.3	9.1	4 current	Mixed conifer	B3a / 14	14	42	94	No data

Table 26. Reach information for other tributaries in the Camp Lick planning area

Name / reach	Reach length (miles)	Reach	Forest type	Large woody debris / mile	Key pieces (%)	Shade	Stream temperature (degrees Fahrenheit)
Big Rock Creek 1	0.8	1 desired	Mixed conifer	80-120	20	50-65	60.8
Big Rock Creek 1	0.8	1 current	Mixed conifer	24	3	58	64.5
Big Rock Creek 2	0.4	2 desired	Mixed conifer	80-120	20	50-65	60.8
Big Rock Creek 2	0.4	2 current	Mixed conifer	23	2	96	No data
Charlie Creek 1	0.7	1 desired	Mixed conifer	80-120	20	50-65	60.8
Charlie Creek 1	0.7	1 current	Mixed conifer	15	22	80	No data
Cougar Creek 1	2.2	1 desired	Mixed conifer	80-120	20	50-65	60.8

Name / reach	Reach length (miles)	Reach	Forest type	Large woody debris / mile	Key pieces (%)	Shade	Stream temperature (degrees Fahrenheit)
Cougar Creek 1	2.2	1 current	Mixed conifer	70	1	71	No data
Cougar Creek 2	0.9	2 desired	Mixed conifer	80-120	20	50-65	60.8
Cougar Creek 2	0.9	2 current	Mixed conifer	8	0	91	No data
Eagle Creek 1	0.7	1 desired	Mixed conifer	80-120	20	50-65	60.8
Eagle Creek 1	0.7	1 current	Mixed conifer	18	45	75	No data
Eagle Creek 2	0.8	2 desired	Mixed conifer	80-120	20	50-65	60.8
Eagle Creek 2	0.8	2 current	Mixed conifer	31	24	74	No data
Little Trail Creek 1	1.5	1 desired	Mixed conifer	80-120	20	50-65	60.8
Little Trail Creek 1	1.5	1 current	Mixed conifer	42	4	82	No data
Shoberg Creek 1	0.6	1 desired	Mixed conifer	80-120	20	50-65	60.8
Shoberg Creek 1	0.6	1 current	Mixed conifer	7	4	70	No data
Shoberg Creek 2	1.2	2 desired	Mixed conifer	80-120	20	50-65	60.8
Shoberg Creek 2	1.2	2 current	Mixed conifer	21	6	80	No data
Sulfur Creek 1	Unknown	1 desired	Mixed conifer	80-120	20	50-65	60.8
Sulfur Creek 1	Unknown	1 current	Mixed conifer	82	Unknown	No data	69.4, 55.3
Trail Creek 1	2	1 desired	Mixed conifer	80-120	20	50-65	60.8
Trail Creek 1	2	1 current	Mixed conifer	5	0	83	No data
Whiskey Creek 1	1.3	1 desired	Ponderosa pine	80-120	20	50-65	60.8
Whiskey Creek 1	1.3	1 current	Ponderosa pine	0	0	43	No data
Whiskey Creek 2	2	2 desired	Ponderosa pine	80-120	20	50-65	60.8
Whiskey Creek 2	2	2 current	Ponderosa pine	1	0	90	No data